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Generating Cams and Irregular-Shaped Work

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Few mechanics realize the capabilities of the gear shaper for generating cams or other irregular forms on a commercial basis. This article briefly outlines some of its interesting possibilities in this line of work.

THE production of irregular-shaped work, such as gas-engine cams of the individual type and airplane cams, has up to within the past few years been completed by milling, using formers to control the action of the milling cutter or profiling cutter, depending upon the type of machine used for this purpose. The accuracy of the cam will therefore depend upon the accuracy of the former used in controlling the cutter, and to a certain extent upon the dexterity of the operator and the rigidity of the machine on which the operation is accomplished. The chief difference between generating and forming is that with the generating tool greater accuracy is possible.

The production of cams on the gear shaper is not only a simple proposition but it is also accurate and fast. It is possible with the gear-shaper to obtain in a commercial way cams that are very difficult to produce accurately by tool-making methods.

Probably one of the simplest examples of a cam which can be generated is that used on large gas engines where exhaust and inlet cams are made from individual forgings and are pinned onto the camshaft. This process, of course, is not followed to any great extent in automobile engines, because as a general rule the cams and shaft are made integral with each other. Fig. 1 shows a set of inlet and exhaust cams for a gas engine, also the gear-shaper cutters used in producing them. Fig. 2 shows diagrammatically another form of gas-engine cam and an outline of the gear-shaper cutter used in producing it. Once the rolling circles for the gear-shaper cutter are determined, the generating of a cam becomes as simple as the generating of gear teeth. These two imaginary rolling circles, which are the same as the pitch circles of two gears in mesh, will give us the correct center distance, so that the cutter and cam roll in proper step with each other and thus generate the correct outline. The index wheels are rotated in step with each other by change gears in the same manner as when an ordinary gear is being cut. Cam cutters, of course, are special, the shape being controlled entirely by the shape of the cam it is intended to reproduce.

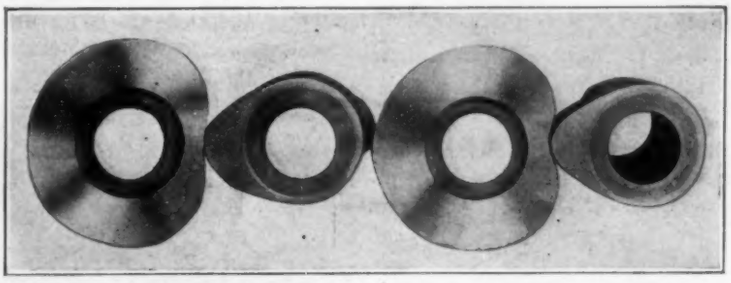


FIG. 1. INDIVIDUAL GAS-ENGINE CAMS AND CUTTERS USED IN PRODUCING THEM

One type of airplane engine which works on the rotary principle uses inlet and exhaust cams of the disk type. One of these, the exhaust cam, shown in Fig. 3, has five principal lobes, which must be all of exactly the same shape and height from the center. Considerable difficulty has been experienced in producing these cams in order to obtain the desired accuracy. The gear shaper, however, has greatly simplified the problem, as will be explained.

When we look at this problem from the standpoint of generation we see that with a properly shaped cutter rotating in the correct relation to the blank we can generate a cam that is much more accurate than can be produced by any other method. The cutter used in producing this cam does not have anywhere near the same appearance as the cam itself, as will be seen by reference to Fig. 3. Fig. 4 shows diagrammatically just how this form of cutter generates the cam. In operation, as shown in Fig. 5, the cutter and work are rotated in unison with each other and the rolling is done on two imaginary circles, which are identical with the pitch circles of two gears in mesh.

As the cutter and cam blank roll around in mesh with each other the outline is generated on the cam, as is illustrated by the fine lines in Fig. 4, these indicating the various positions of the cutter as it is rolled in contact with the blank. In this illustration it should be explained that the cutter has been rolled around the blank, the latter remaining stationary in order to greatly simplify conditions and make the drawing clearer. In cutting these cam blanks a batch of two or more, but preferably eight blanks, the blanks being $\frac{3}{8}$ in. thick, is held on the fixture, thus giving a total face width of 3 in. In the illustration, Fig. 5, only five blanks are being cut. The inlet cam is also produced

in the same manner with a different form of gear-shaper cutter.

A peculiar form of cam, which in this case fills the

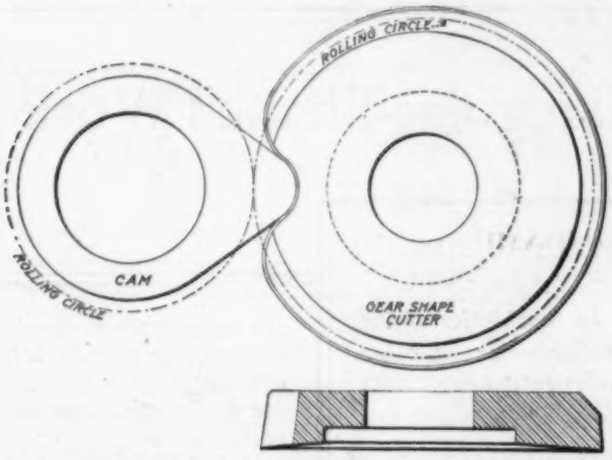


FIG. 2. DIAGRAM SHOWING PROPER OUTLINE OF CUTTER FOR PRODUCING INDIVIDUAL GAS-ENGINE CAMS

function of an impeller for an oil-measuring machine, is shown in Fig. 6, together with the gear-shaper cutter used in producing it. The cutter shown at *A* is used

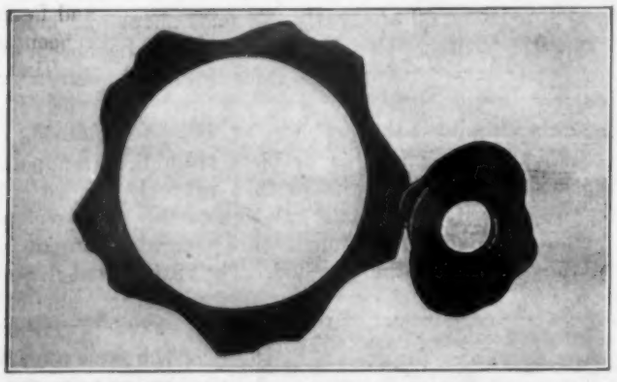


FIG. 3. EXHAUST CAM FOR GNOME ENGINE AND THE CUTTER USED IN PRODUCING IT

for finishing the plain surfaces of this impeller, whereas the cutter shown at *B* is used in producing the irregular outlines. Owing to the peculiar shape of this part

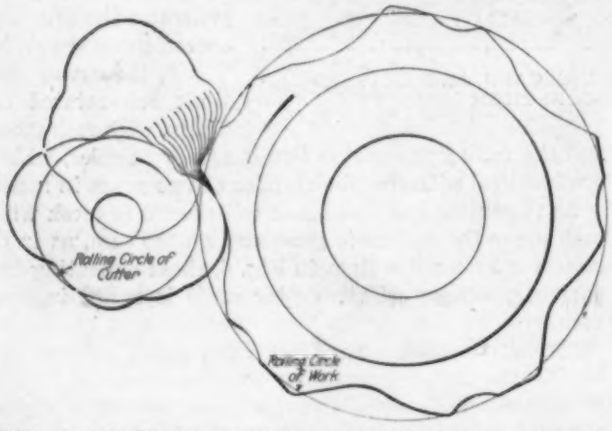


FIG. 4. DIAGRAM ILLUSTRATING HOW OUTLINE FOR CAM IN FIG. 3 IS DETERMINED

two cutters can be depended upon to give greater accuracy and it also simplifies the shape of the cutters used. Fig. 7 presents diagrammatically the two cutters illustrated in Fig. 6 and shows in a simple manner how these two forms of cutters generate this impeller. At *A*, Fig. 7, is shown the cutter used for finishing the circular surfaces of the impeller; *B* is the cutter for generating the other outlines of the impeller. The portions on this impeller that are generated are indicated by finish marks. The acting surfaces on this impeller, as indicated at *B*, are involute curves having a pressure angle of 30 deg., thus it will be seen that essentially this impeller is a two-tooth gear and has two tooth spaces in which the mating impeller teeth mesh.

Fig. 8 shows the impeller illustrated in Fig. 6 set up on the gear shaper. It will be noticed that the cutter for finishing the irregular outlines is in action on the work. As the cutter and impeller have rolling circles of the same diameter the upper and lower index wheels that

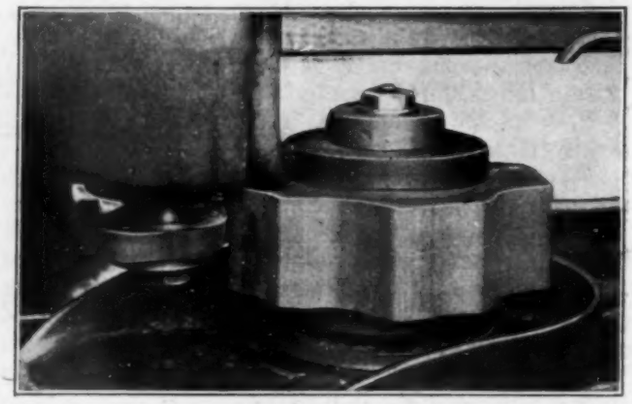


FIG. 5. GEAR SHAPER IN OPERATION CUTTING CAMS OF THE TYPE SHOWN IN FIG. 3

control the rotation of the work and the cutter rotate the latter at the same speed. This is identical with the action of cutting a spur gear of the same pitch diameter as the cutter used in producing it. We therefore see that a cam when generated on the gear shaper fol-

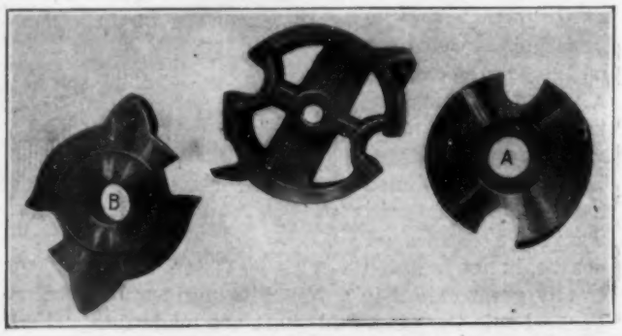


FIG. 6. IMPELLER FOR AN OIL-MEASURING MACHINE AND CUTTERS USED IN PRODUCING IT

lows the same principle as the generating of a gear tooth.

Fig. 9 shows an interesting form of cam, which would be very difficult to produce by milling. Here we notice that the circular surface is concentric with the axis, but there is also an irregular and angular surface having a very sharp depression. This it will be noticed cannot be produced by an end-milling cutter, and the only way in which this cam can be made by milling would be to mill the circular surface in one operation and then by means of a form-milling cutter produce the

other surfaces of the cam. This would require two settings and accurate duplication would be extremely difficult.

By the generating method, and the use of the gear-shaper cutter, the production of this cam in quantities

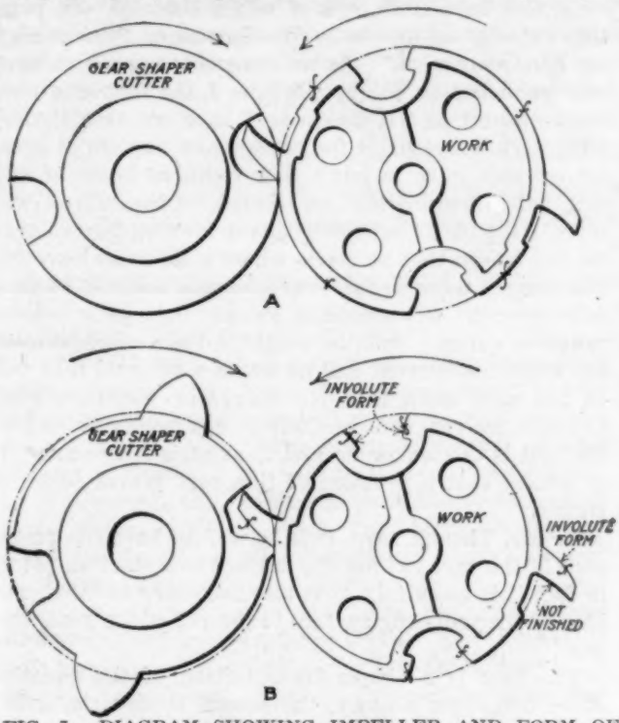


FIG. 7. DIAGRAM SHOWING IMPELLER AND FORM OF CUTTERS USED IN ACCURATELY GENERATING THE ENTIRE OUTLINE

becomes a comparatively simple matter and also a cam can be generated with a high degree of accuracy. The way in which this cam is generated is illustrated clearly in Fig. 10, which shows a cutter in action on the work. One of the three holes is used for locating purposes in the fixture so as to bring the angular surfaces of the cam—the highest point—in the proper relation to the

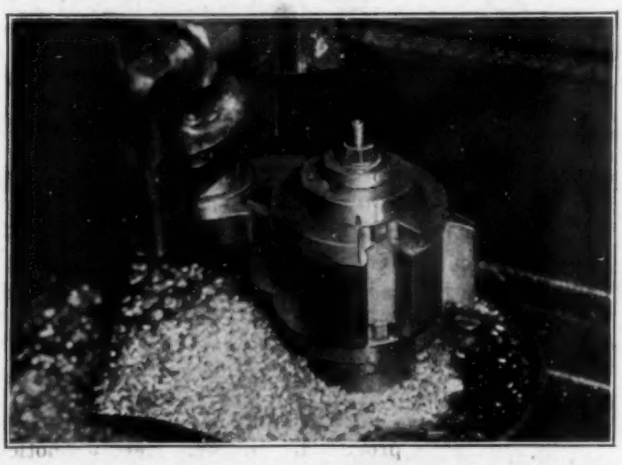


FIG. 8. CLOSE VIEW OF GEAR SHAPER AT WORK ON IMPELLER SHOWN IN FIG. 6

cutter. The cam is held on a close-fitting plug that is retained in the fixture and then is clamped to the plug by the means of a nut as illustrated. In setting for cutting, the highest point of the cam is brought into the correct relation to the cutter, then the cutter is fed in to depth and the feed automatically engaged for rotating. In this case it will be noticed that the cutter has twice the diameter of the cam it is intended to reproduce, and therefore makes only one-half revolution in producing the entire surface of the cam.

Fig. 11 shows in diagrammatic form a breech block for a field gun upon which there is a series of interrupted gear teeth and a cam surface. This illustration clearly shows the form of gear-shaper cutter that is used in reproducing these interrupted teeth and the cam surface. The cutter is shown in three positions, *A* showing the

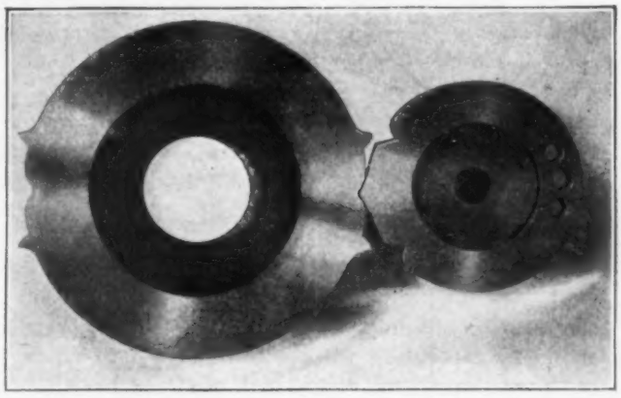


FIG. 9. CAM FOR MOTION-PICTURE MACHINE AND CUTTER USED IN PRODUCING IT

generating of what might be called a double tooth, and *B* and *C*, illustrated by dotted lines, the cutter at the extreme ends of its action. The cutter only generates three-quarters of the way down the curve, or fillet, at the position *C*, the remainder being completed by milling, and only generates a part of the flat surfaces at *B* to the point illustrated, the remaining surfaces being completed by milling. What therefore appears to be a very difficult proposition becomes a simple matter when

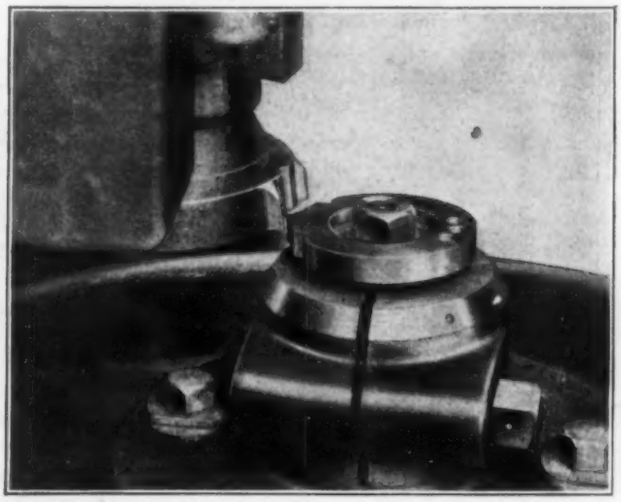


FIG. 10. CLOSE VIEW OF GEAR SHAPER AT WORK GENERATING MOTION-PICTURE CAM SHOWN IN FIG. 9

considered from the standpoint of the generating method.

Ratchets, milling cutters, etc., have, as a general rule, been produced by milling, but the generating process within the past few years has been used to a considerable extent for this purpose. There are two reasons for this. First, the generating cutter will produce an accu-

rately spaced ratchet or milling cutter, and, second, because it is faster than milling. This last statement may appear to be an exaggeration, but tests on the same form of ratchet have shown that the gear-shaper method is much faster than that of milling. Fig. 12 shows the

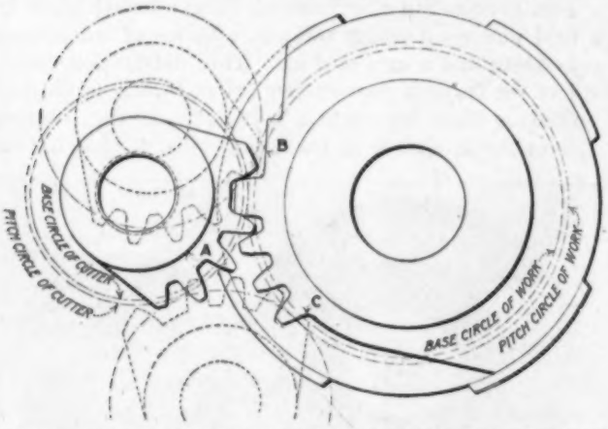


FIG. 11. DIAGRAM ILLUSTRATING SPECIAL CUTTER FOR GENERATING CAM AND INTERRUPTED GEAR

gear shaper set up and in operation cutting ratchet teeth. In generating ratchet teeth it is impossible to secure a sharp corner at the bottom of the tooth space. The cutter, in rolling, always sweeps up a fillet, the height of which is largely governed by the depth of the

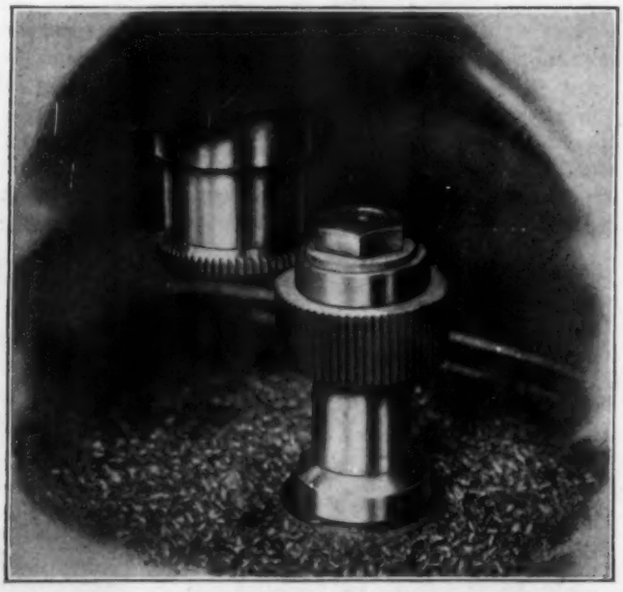


FIG. 12. ILLUSTRATION SHOWING GEAR SHAPER AT WORK PRODUCING RATCHETS

tooth and the included angle of the tooth space. This fillet, however, tends to strengthen the tooth.

The foregoing examples of cams and similar irregular-shaped work serve to show the successful application of the generating process. These have been selected as representative of the types of cams that were formerly made by milling. However, there are certain limitations to the generating process. For instance, it would be possible to conceive of a depth of cam that could not be generated because the generating tool would "gouge" out or interfere with the member being cut; also it is impossible to produce an undercut on a ratchet by the generating process.

Calculating for Electromagnets

By F. T. Fawcett, M.A., D.Sc.
Palestine

A bundle of copies of the *American Machinist* reached me a few days since, one of which contains (on page 494, Vol. 48) an article by W. Thomas on "Calculating for Electromagnets." As no comments appear to have been published by you up till June 8, the following may be of interest to Mr. Thomas. I have not seen Underhill's work on solenoids for some years, and am at present not able to be in touch with technical books of any sort, but I imagine that no treatise on the subject will refer to the particular problem laid down by Mr. Thomas for the reason that he starts where most folks leave off. The normal thing is for one to want a solenoid to do a definite work—lift a definite amount through a definite range or carry a definite weight. Your correspondent has a definite current and he wants a solenoid that will do the most work with it. Range of motion, stroke, lift, size, weight, none of these things matter so long as the load is the maximum and the size is reasonable. It is seldom that a problem of this sort proves to be so simple.

As Mr. Thomas says, it is as well to have the resistance of the wire to limit the current as a starting point; in fact it is essential. It is also necessary to have some idea of the radiating surface to get rid of the generated heat.

The first is a simple transposition of the equation $E = CR$ (Ohm's Law), the second is empiric, and a fairly good area is 1 sq.in. of surface per watt. The condition given is a battery of 6 volts capable of supplying 6 amp., and from this the limiting resistance $R = \frac{E}{C} = \frac{6}{6} = 1$ ohm. The power is $C^2R = 6^2 \times 1 = 36$ watts and at 1 watt per square inch the area of the outside of the solenoid must be 36 sq.in. A number of sizes of solenoid will naturally present this surface area, but a well-balanced design is one of 2 in. in diameter 6 in. long or one of 3 in. in diameter 4 in. long. Each has an area of rather more than 37 sq.in. Take the second size with a 1-in. core. The current to be carried is 6 amp., and a reasonable sized wire for such a current would be No. 16 S. W. G. This has a resistance of about 0.007 ohm per yard, and consequently 143 yd. are required to make up the necessary resistance of 1 ohm. The wire over the insulation has a diameter of about 0.07 in. and therefore the solenoid will contain about 798 turns of wire. The mean length of one turn is 6.28 in., giving a total length of roughly 140 yd., which is sufficiently near to the requirement for 1 ohm. This will on calculation be found to be the most convenient size, as a 6 x 2-in. solenoid will require an impossible small core in order to contain a sufficient length of wire.

There are a number of considerations which control the design of solenoids, most of which will be found in any good book on the subject, and tables showing the resistances of conductors, areas, safe current-carrying capacity and other particulars are obtainable through any publisher of electrical literature in London. The London Electric Wire Co., Golden Lane, E.C., I know, used to publish very complete particulars in the form of its catalog.

Extracts From Chordal's Letters

IN THIS letter Chordal tells us something about planing machines and their diseases, both inherent and acquired. He gives some of his own experiences in working with such machines. Also he shows how the flat surfaces of much small work usually planed can be done in a lathe with some help from the cold chisel.

MR. EDITOR:

* * * That book you were kind enough to send me, "Wild Animals I Have Known," by Ernest Seton, was extremely readable and interesting, and taught me more about a few of these gentle creatures than I have ever dreamed of before. I say this book is by Ernest Seton, but it is hard to tell whether it is Ernest Thompson or Ernest Seton or Ernest Seton Thompson. But in any event the animals are all right and the gentleman with the doubtful name knows about them.

* * * If you could get some real experienced machinist to write something about "Wild Planers I Have Run" he could, I think, give something very much along the animal line; at least I judge so from my own rather limited experience with planers I have run, and planers I have tried to run, and planers that I have heard of.

* * * It seems to me that I remember telling you long ago of the little old machine shops that seemed to have everything else but had no planer, and it is wonderful how much planing you can do without if you have to, and if you cannot do without it it is wonderful how much planing these little shops manage to do without having any planer. Take, for instance, a broken strap on the connecting-rod of an engine—something of fair size, say a strap for an engine with a 20-in. cylinder. The forging as it comes out of the blacksmith shop would be about as ugly looking a thing as you would care to look at, about such a thing as would be forged down from the nearest sized iron and then bent up into something like the shape wanted and, luckily, with plenty of stock left for finishing. This is a planer job all right, but you would find the shops I speak of have worried out a very respectable job done on the lathe and vise.

* * * First, the affair would be chucked and one side faced off, and then would be reversed and the other side faced off, and that facing would of course be as good as any planer could do it. Then the strap would be chucked and bored for the half-round brass. Then the strap would be shifted in the chuck and bored again the same size through the flat inside part. Here were all the gages the chipper would want in getting the inside to nice size and out of wind. Then would come the chucking and the facing off of the top of the strap, and then the bottom, and then the strap would be plugged and put between the centers endwise and the ends faced nice and square, and then it would be turned around endwise and the round end of the strap would be faced off to produce a gaging surface. Then the vise man would tackle the job with chisel and file, and after drilling and mortising he would go at it with emery paper, and when he would lay that job down you might look at it with a spyglass without being able to find a particle of fault with it as a job of planing.

* * * And when this little old shop did get a planer it had very little to do, and it was nobody's and everybody's business to run it, the consequence being that even if it was a decent sort of a planer it was never in condition to run, and it was likely to be wanted for an hour's work by every Tom, Dick and Harry about the shop. There would be no tools and no bolts, but these would be cribbed from some of the lathes. All of this was easy enough if the planer happened to have a belt on it, but the chances were that the last chap who used the planer broke the belt when his job was half done, the job being completed in the vise, and the belt being allowed to lie were it happened to tumble off. Our new man would therefore probably have to rig up his belt before he could determine whether or not the planer was otherwise usable.

* * * There are two kinds of planers, one using open and crossed belts to get the cutting and backing motions, the other kind using a single belt and having backing gearing among the insides of the planer. The single-belt type of planer had distinct advantage in such a case as I have above mentioned, for Joe would have to rip up only one belt instead of two.

* * * In these old single-belt planers, which seem to have gone out of fashion, there would be three pulleys on the thing—a cutting pulley and a backing pulley and a loose pulley in between—and, in reversing, the belt would require to be shifted all the way across from one outside pulley to the other, which it did all right, providing the planer did not take a notion to stop entirely while the belt was on the loose pulley. In the modern planers, with their two belts, there are two loose pulleys and one wide, tight pulley between, and the reversing act consists in shifting one belt off of the tight pulley and then shifting the other one onto it.

* * * I can well remember my occasional tackling of a little planer we had in the shop made to plane about twenty inches wide and five feet long. I believe it was of English make and the workmanship everywhere about was of tiptop character. But the modern designer of machine tools would be very apt to say that this little old planer was far from being complete. The rail was hung on one elevating screw which attached to the middle of the length of the rail and it was no easy matter to get this rail parallel across the

table. Again, there was no automatic down feed for the tool at all. If you wanted the tool fed down the best thing you could do was to feed it down yourself. And the down-feed screw, instead of having a hand-wheel or a crank with one handle, had two crank handles to it, which makes me think the machine was English.

* * * And the chuck that was on this planer! One would rather wonder where in the world the old man ever picked it up or what he picked it up for. It never belonged to that planer at all. It was one of these turntable affairs you could turn around at any angle, but it had been turned down to make it small enough to go between the housings, and the part that had been turned off was the part originally intended for clamping the chuck to the planer table, and some other clamping arrangement had to be found for it.

* * * This planer operated with a chain having each end fastened to the table, the chain being wound several times on a grooved drum, and passing over an idler at one end of the bed.

* * * This planer was evidently intended to plane 5 ft. long, but it would not do it, for the table would kick up and try and get off the bed at each end of 4 ft., and it would have got off the bed if it had not been for the salvation found in that blessed chain. You would use good judgment if you kept your desire safely within 4 ft. on this planer, and then near one of the ends of this 4 ft. there was a spot where the table wanted to jump a trifle, and you would do well to guard against this. The trouble was due, I fancy, to the fact that at one time the chain had broken and been repaired by a particularly fat link which possibly struck the underside of the table.

* * * I remember another planer, a real rack-and-pinion planer this one was, that had about half a dozen distinct serious diseases. Not within any man's memory had this planer of its own accord made a reversal. When you wanted it to reverse you had to reverse it yourself, which you would do by a very slight effort on the reversing tumbler. Possibly if someone had looked into the matter the defect could have been cured, but it was nobody's business to look into the matter.

* * * In this planer the feed was carried from the feed tumbler up to the rail by means of a slender rod, and each time the rail was raised or lowered on the housings the rail connection with this rod had to be loosened up and tightened again after the rail was in place. This simple fact was generally overlooked until the rail would not go down any further and the rod became bent and required to be straightened. I believe there is some way of telling the age of a horse by counting the wrinkles in his teeth, and I believe that you could have got at the antiquity of this planer with fair accuracy by counting the crooks in this feed rod due to defective straightening. The usual process of straightening would be to take the rod off and lay it down on the table of the planer and hit it a lick or two with a hammer and then put it back and let it go, if it would go.

* * * I have in mind another planer which would reverse all right as long as you cared to run it. But it required help in other directions. The feed was by means of a ratchet on the rail and there was a tooth or two missing, and if you wanted your feed kept up with any regularity you had to be on the lookout for the time when the skips would take place, so you could help the thing over the hills, or rather over the valleys represented by the broken teeth.

* * * This reminds me that long years ago Johnnie, who forced his way into the shop by being a nuisance while he was at school, and has since forced his way to the top of all shops, had never seen a planer when he was in the third year of his apprenticeship. But he knew all about planers and had omnivorously devoured every woodcut and catalog he could find on the subject of planers until he could lip off to you every detail of about every planer on sale in the United States. He had simply studied the things out diligently, and where the pictures did not show things up plainly he would manage by hook or crook to reason out what the construction was.

* * * But he came across a woodcut of a Pratt & Whitney planer that stumped him. He knew all about the swings and the aprons and the nests of bevel gears at the center of the swing, and he had a clear understanding of all the different click boxes. But this planer showed on the crank at the top of the down-feed screw of the head something that Johnnie could not understand. There seemed to be a crank with four balls to it, one more ball than any ordinary crank has any use for, and the top of this crank bore some little mechanism which Johnnie could not tell about. He reasoned over the thing and probably dreamed over it, and finally in pure desperation he wrote to the Pratt & Whitney company telling them the case plainly that he had never seen a planer, but believed he knew most all about them, but that this business on this crank bothered him and he wanted to know what it was, what it was for, and how it worked. His letter might very nicely have gone into the waste basket, but as good luck for Johnnie would have it back came an answer from Mr. Pratt explaining perfectly just what that thingumbob on the crank was for. This made Johnnie happy for now he could sleep o' nights. He explained the thing to me shortly afterward, but I forget about his explanation.

Very respectfully,

CHORDAL.

Chart for Determining Planing Time

BY A. LEWIS JENKINS

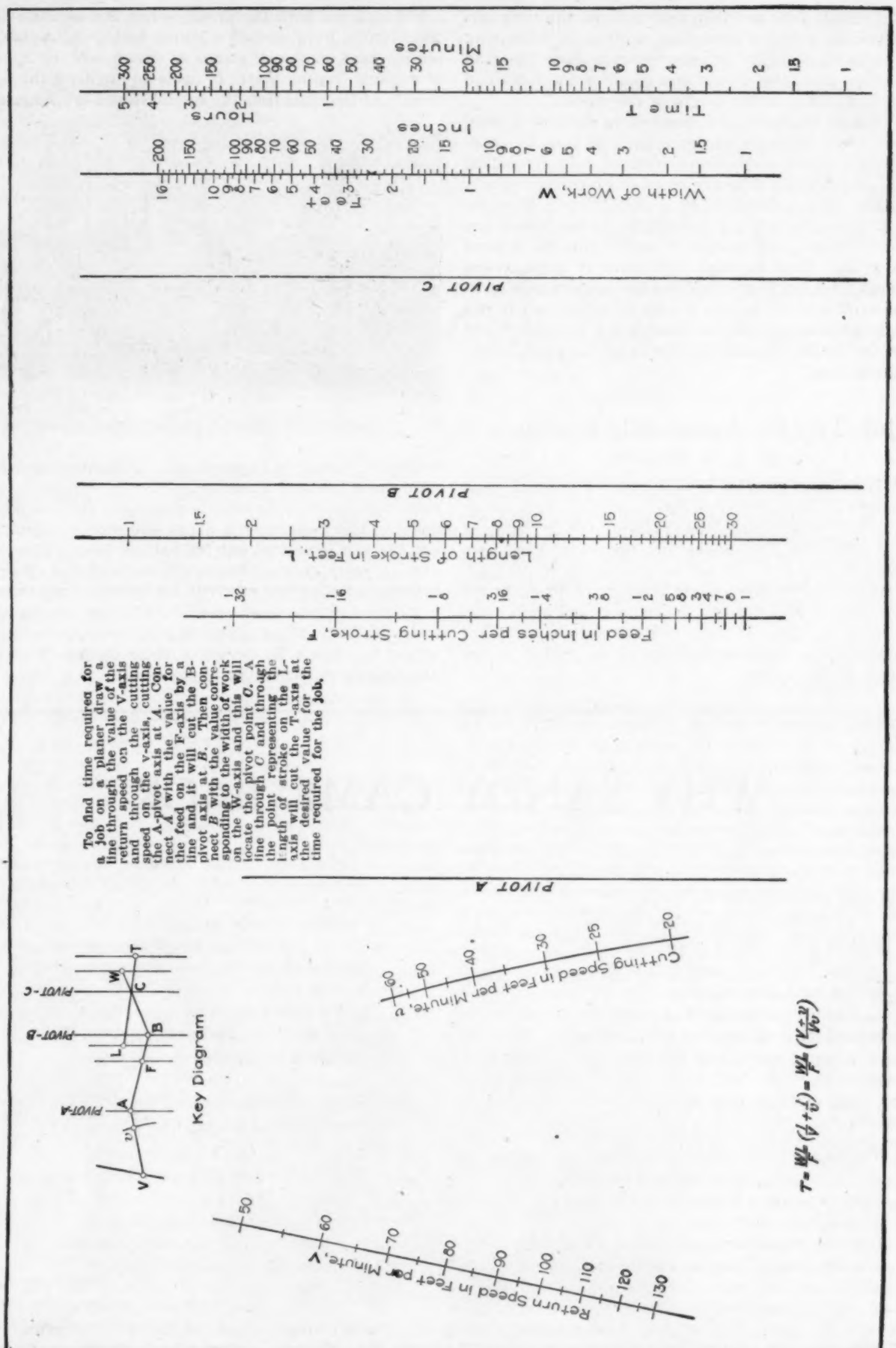
Mathematical expression for finding the time for planing-machine work involves the sum and product of the speeds and renders its solution tedious although not complicated. Special slide rules for this purpose require a set of curves or special settings which are more or less liable to introduce errors. Charts supplemented by tables or curves have the same objection.

The formula for determining the time required for a job on a planing machine is:

$$T = \frac{WL}{F}\left(\frac{V+v}{Vv}\right) = \frac{WL}{F}\left(\frac{1}{V}+\frac{1}{v}\right)$$

Where

T = Time required in minutes;
W = Width of the work in inches;
L = Length of stroke in feet;
F = Feed per working stroke of the planer;
V = Return speed of the table in feet per minute;
v = Forward speed of the table or cutting speed in feet per minute.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Feed in Inches per Cutting Stroke, F
PIVOT A
To find time required for a job on a planer draw a line through the value of the return speed on the V-axis and through the cutting speed on the v-axis, cutting the A-pivot axis at A. Connect A with the value for the feed on the F-axis by a line and it will cut the B-pivot axis at B. Then connect B with the value corresponding to the width of work on the W-axis and this will locate the pivot point C. A line through C and through the point representing the length of stroke on the L-axis will cut the T-axis at the desired value for the time required for the job.
Cutting Speed in Feet per Minute, v
Return Speed in Feet per Minute, V
Key Diagram
PIVOT-C
PIVOT-B
PIVOT-A
T
W
C
B
L
F
A
V
v
$T = \frac{W}{12} \left(\frac{1}{v} + \frac{1}{V}\right) = \frac{W}{12} \left(\frac{v+V}{vV}\right)$

This formula does not take into account the time lost in reversing unless a correction is made by increasing the value of L. This increase depends upon the kind of pulleys used, the weight and speed of the table and work and also upon the length of the stroke.

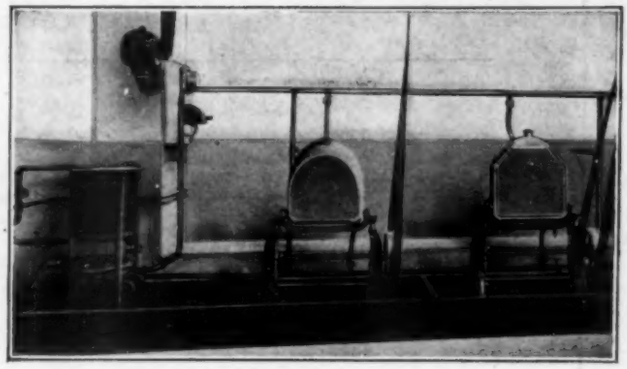
Problem: Find the time required to machine a piece whose length requires the equivalent in time of an 8-ft. stroke, 30 in. wide, with a feed of $\frac{1}{8}$ in., a cutting speed of 40 ft. and a return speed of 80 ft. per minute. Solution: This makes $V = 80$, $v = 40$, $F = \frac{1}{8}$, $W = 30$, and $L = 8$. Draw a line through 80 on the V-axis and 40 on the v-axis, and produce it until it cuts the A-pivot axis at A. Then through this point A draw a line through $\frac{1}{8}$ on the F-axis, cutting the B-pivot axis at B. Connect B with 30 on the W-axis by a line and it will cut the C-pivot axis at C. Then a line through C and 8 on the L-axis will cut the T-axis at 72, which is the required time.

Jolt Test for Automobile Radiators

By E. A. Thanton

It is common practice to test automobile or airplane radiators in the factory previous to sending them out by completely submerging the radiator in a bath of water after the filler orifice and the outlet have been sealed and a flexible pipe has been connected to the inlet. By means of this pipe an air pressure of 15 lb. to the square inch is sent through the radiator and maintained for 10 or 12 min. If there are any defects these are immediately revealed by bubbles of air rising to the surface of the water.

Not satisfied with the pressure test the engineers of the Fiat Co. have devised a jolting test. The radiators are mounted on special stands as shown, and, by means of a pump, boiling water is made to circulate through them. At the same time the special stands are subjected



RADIATORS UNDERGOING JOLTING TEST

to intense vibration by means of a reciprocating movement in a vertical direction. This movement is imparted by means of an electric motor and suitable mechanism. The movement is about 300 strokes a minute and the test is carried out for half an hour. This test gives a more severe shaking to the radiator than is experienced when the car is in low gear and the engine is running at maximum speed. Radiators passing this test without showing signs of weakness can be guaranteed to operate on the car without danger of giving any trouble to the owner.

WHY SANDY CAME BACK

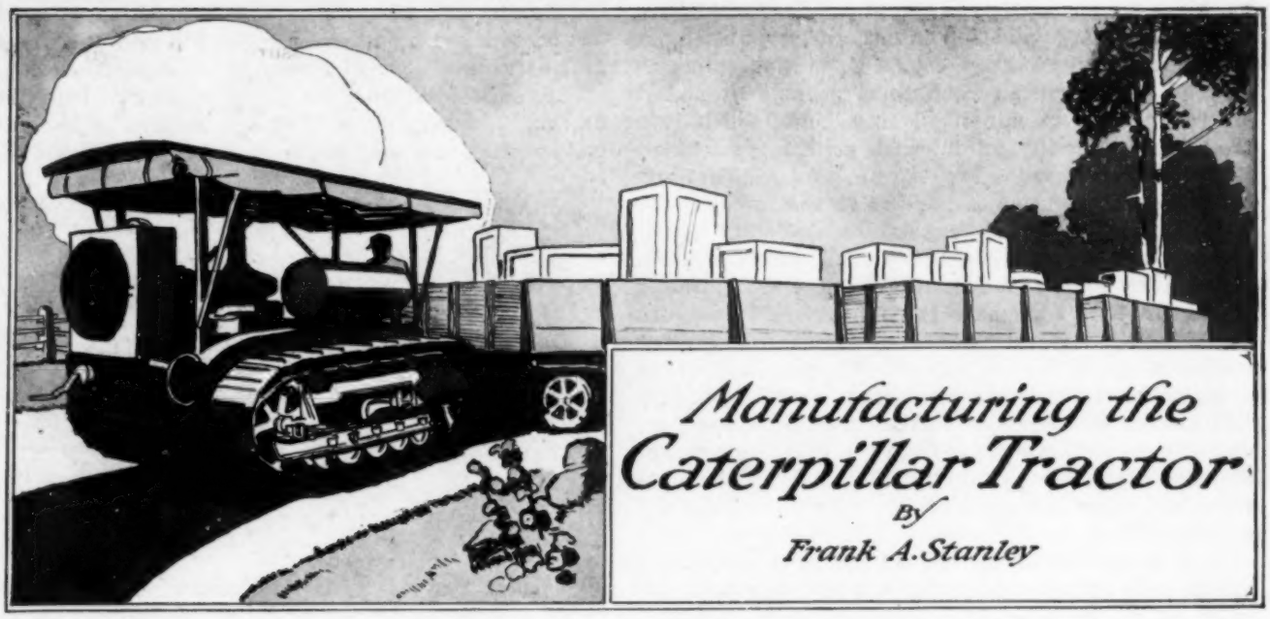
By Rufus T. Strohm

Sandy got caught by the draft
At the start of the present asperity,
Packed up his kit and waved us his mit
And beat it for camp with celerity.
Left a big hole in the shop,
For toolmakers aren't so numerous;
Seemed for a while it was painful to smile,
Since no one exactly felt humorous.

Picture him next at the camp,
In the midst of that soldierly scenery,
Shedding his duds and helping peel spuds
As though he were chef in a beanery;
Later, a driver of mules,
Taking his training progressively,
Learning to cuss in French, cockney and Russ,
And doing it wondrous expressively.

Yesterday Sandy came home,
Sunburnt and sober and serious;
Gossip and hag set their tongues on the wag
And vowed that the cause was nysterious.
Sandy came back to the shop,
Settled right down with the rest of us,
Handling the mikes, the saddles and the likes,
And doing his bit with the best of us.

Wounded, you think? Guess again!
Nary a sign of a scratch on him.
Sickly, you say? Gee-whillikins, nay!
Why, healthiness isn't a patch on him.
'No; Uncle Sam has got wise
To our criminal waste of ability;
Now he takes care that each man does his share
Where he's of the greatest Utility.



Manufacturing the Caterpillar Tractor

By

Frank A. Stanley

I. General Features

This first installment gives a brief outline of some of the important features of this widely known tractor which lays its own track and proceeds with equal facility over rough or even ground and over soft or hard material. The description is confined in the main, however, to the Stockton, Calif., factory (one of the two big plants where these tractors are built), which is today one of the best-equipped machine shops of this character in the West.

WHEN General Swinton, inventor of the British army tank, made his recent visit to the plant of the Holt Manufacturing Co. at Stockton Calif., he found that the home of the "Caterpillar" tractor,-the machine primarily responsible for the design of the armored tank, had experienced a growth in capacity during the past four years of fully five fold, this making it with its 2500 workmen one of the biggest machine-building establishments on the Pacific Coast, and one which holds today, to the best of my knowledge and observation, a first place among the plants of the Far West in point of equipment.

The "Caterpillar" tractor needs no introduction to readers of this paper. In earlier designs it has been fully described here, but its application in recent years to purposes of war has made it one of the most familiar pieces of mechanical apparatus to readers of the general press, so no extended description of it will be given at this time.

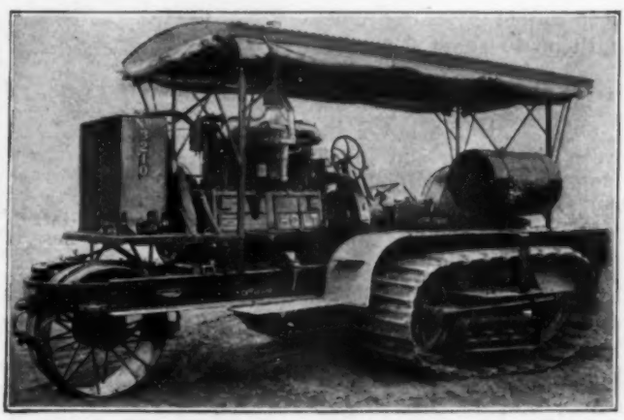


FIG. 1. 75-HP. "CATERPILLAR" TRACTOR

This article and others to follow will deal in detail with some of the important shop processes of manufacturing this machine at Stockton, Calif. Similar shop methods as well as others of special character are in practice at the big eastern Holt plant at Peoria, Ill., this plant being now devoted entirely to the production of "Caterpillar" tractors for the United States and Allied army use.

Certain Features

Two standard sizes of the tractor, respectively 75 and 45 hp., are illustrated here. Fig. 1 is a front view of the former and Fig. 2 is a rear view of the latter. The principal differences in design and in operative features will be obvious upon examining the views, and the characteristic feature of each machine, the linked-steel endless track, will be equally apparent. While differing in dimensions and in method of mounting, the endless track is of practically the same construction on both the 75- and 45-hp. tractors. Fig. 3, which is a detail of one of the track-operating sprocket units, gives an excellent idea of the strong, powerful design which has been followed throughout in the construction.

It may be stated very briefly that all parts of these tractors, from engine to track, are produced by the most advanced methods in respect to materials of construction and manufacture. As these articles continue it will be found that such members as crank and other shafts, spur and bevel gears and other parts are made of high-grade alloy steels, heat-treated, hardened where required, and finished by grinding. Crankshafts are finished from drop-forgings by means of engine lathes, special crankshaft lathes and cylindrical grinding

machines for main bearings and pins. Gear blanks are turned out in large numbers on modern turret machines and lathes; their teeth are cut on hobbing machines in the case of spur gears, and bevel gears are handled on gear-planing machines, all sizes being finished in the bore by means of internal grinding machines. Similarly cylinders, after boring, are finished on cylinder-grinding machines, and so on with other parts. Drill jigs, milling and planing fixtures and other special tools are used in great numbers for all classes of work.

It is little short of a revelation to note the character of the machine equipment throughout the shops. In the grinding department there are some 16 different machines, one of them, a Norton 120-in. plain cylindrical grinding machine, being the largest ever installed in this part of the country. In the drilling-machine bay, occupying a section not far from the grinding bay, are 65 modern machines, including 18 radial, 25 plain upright and other drilling machines of multispindle and sensitive types.

A striking view along one of the rows of drilling machines is reproduced in Fig. 4 and shows each machine set up for some jig-drilling operation. There is much about the work in this department of general

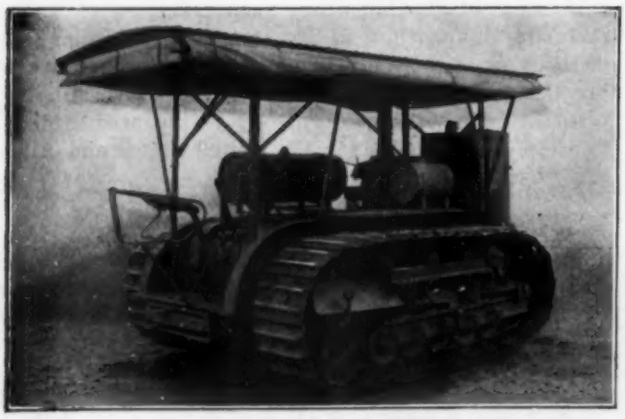


FIG. 2. 45-HP. CATERPILLAR TRACTOR

interest, particularly in respect to the special tools used. These will be described later.

A large number of lathes are devoted to crankshaft turning. One is a Lodge & Shipley crankpin lathe, with special chucking and driving fixtures so mounted on both spindles as to give the work the required degree of offset for turning the pins at the necessary center distance in reference to the main axis of the crankshaft.

These crankshafts are drop-forged from chrome-nickel steel and range in length up to about 6 ft. and in diameter to 3½ inches.

Ordinarily there is about ¼ in. to be removed all the way around on the forgings, or a total of about ½ in. This amount is divided between the rough and finish turning cuts to leave approximately ⅛ in. of stock for the latter cut. The roughing of the main bearings in the lathe is accomplished with a turning speed of about 60 r.p.m. and a feed of $\frac{1}{16}$ in. per turn. The second turning process removes the metal to within about 0.022 in. of size, leaving the amount indicated for grinding.

The drawing of the crankshaft shows all the limits for both turning and grinding, and is therefore a decided convenience in this respect, as it eliminates the element of guesswork as to how much ought to be left on each shaft for removal with the grinding wheel.

The turning of the crankpins is accomplished, as stated, on a lathe with the aid of holding and driving fixtures, and here about the same amount is removed in two cuts from the pins as stated in the case of the

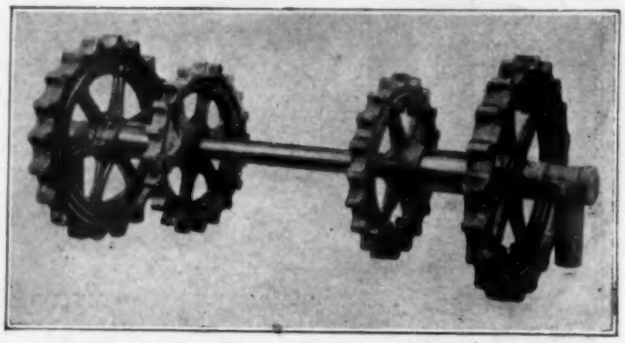


FIG. 3. THE OPERATING SPROCKET SET

main shaft bearings; but the greater portion of this metal is removed by the first cut, leaving say $\frac{1}{32}$ in. only for the second turning cut, which, in turn leaves some 0.025 in. or so for grinding.

The rate of speed for the pin turning is practically the same as for the turning of the bearings. On the roughing cut the rate is 60 r.p.m. and the feed $\frac{1}{16}$ in. per turn. The finish turning, or second cut, is taken with the crankshaft running at the rate of 90 r.p.m. and under the same rate of feed, or $\frac{1}{16}$ in. per revolution.

The manner in which the shaft is dimensioned for

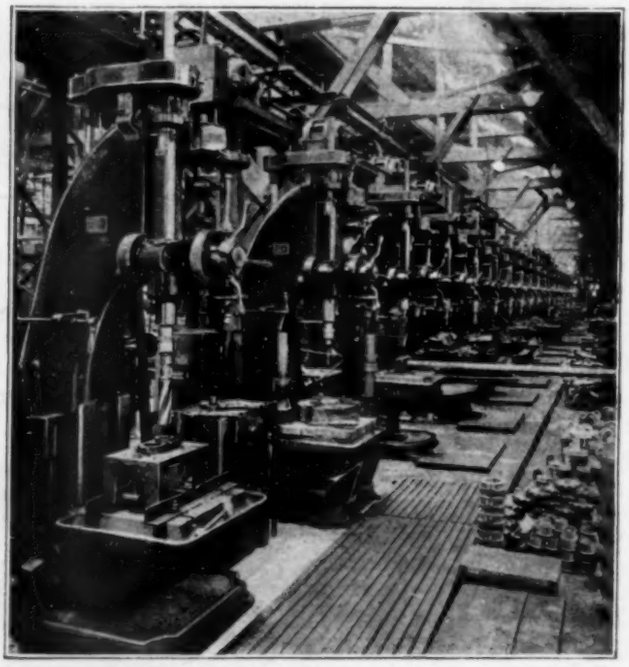


FIG. 4. A LONG LINE OF MODERN DRILL PRESSES

the information of the lathe hands and the grinding-machine operators is shown briefly in Fig. 5, where the end of the shaft proper is marked

$$\text{Turn} \begin{cases} 3.147 \text{ in.} \\ 3.143 \text{ in.} \end{cases} \quad \text{Grind} \begin{cases} 3.1255 \text{ in.} \\ 3.1245 \text{ in.} \end{cases}$$

The crankpin is similarly dimensioned.

These dimensions mean that there is a limit above and below standard for the bearings of 0.0005 in. when ground, the actual size called for being 3.125 in. So with the pins there is here also a limit above and below the standard size of $2\frac{15}{16}$ of 0.0005 in. within which the grinding machine holds the work.

The whole process of carrying such shafts through successive stages in the different shop departments

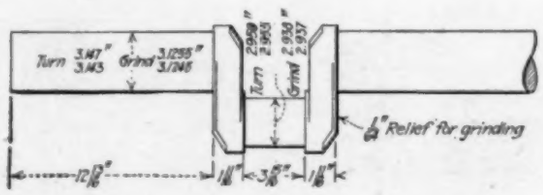


FIG. 5. METHOD OF DIMENSIONING CRANKSHAFT

constitutes a story in itself, and this will be presented in a subsequent issue together with data on grinding-wheel grades, speeds, feeds and other factors.

While this installment has been confined to a few features of the machine shop and its operations, in subsequent articles there will be descriptions of the tool-room, where many unusual undertakings are to be witnessed, and of the foundry, where various interesting molding and core-making processes are done.

Chilled Cast-Iron Dies for Forging and Nosing Shells

BY A. F. WHITE

Owing to the great demand for large numbers of dies for munition work, and as these dies if made of steel would be very expensive, many concerns began to experiment with chilled cast-iron dies.

Requiring dies for forging 4.5-in. high-explosive shells we made some experiments ourselves. As we

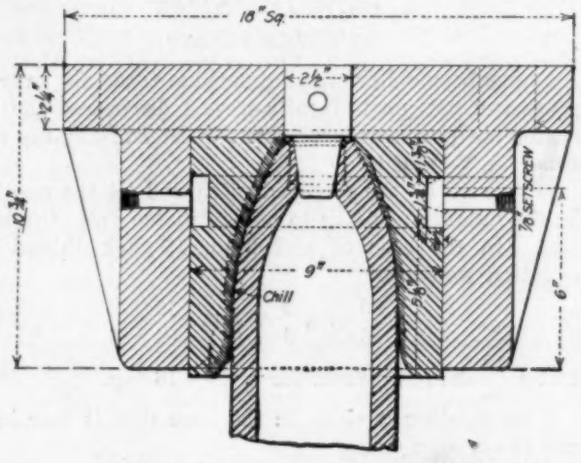


FIG. 1. NOSING DIE AND HOLDER

formerly had some experience with chilled work, such as car wheels, crusher jaws, etc., this together with the success of our experiments gave us considerable advantage over many others, and the result was that we were soon loaded with die orders for practically all the munition works of Canada.

Success in manufacturing chilled dies depends upon the following: Properly graded pig; a supply of hard, close-grained scrap, and heavy chills of the correct shape and size.

Many people attempt to make chilled castings from the same melt as ordinary machinery castings, using the general run of iron, and while a much harder surface and even a slight chill can be obtained in this way the castings will not be chilled deep enough to stand any very hard work.

Chilled iron is the result of chilling or suddenly cooling molten iron by pouring against an iron chill which forms part of the mold. Its discovery is said to have been accidental (some time in the eighteenth century) when the slopping over of a ladle of cast iron caused part of its contents to come in contact with cold iron lying on the foundry floor. In breaking up this scrap it was discovered that the iron was white and much harder than that produced by the ordinary process of pouring metal into a sand mold. The result of this was the introduction of chilled iron for plow points, faces for forge hammers, etc.

One of the most remarkable facts in connection with the process described is that the characteristics of the

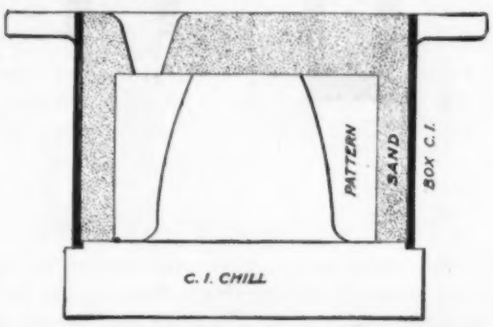


FIG. 2. MOLD FOR NOSING DIE

iron in the castings made in permanent molds are entirely different from those of sand castings. Although the same pig is used in producing castings by the two processes the quality of the iron in the castings is entirely different, and no direct comparison can be made between them. The casting produced in a permanent mold is a different metal, so to speak, from the casting made in a sand mold, though both may be poured from the same ladle. The difference, however, is not of a chemical nature, but is a purely physical one. A soft, open pig iron, high in graphitic carbon, when cast in a chill becomes close-grained, showing no graphite flakes but having the same amount of carbon as existed in the original pig iron. A good mixture that will give excellent results can be made from 300 lb. of charcoal pig containing 0.32 per cent. silicon, 0.17 per cent. phosphorus, 0.23 per cent. maganese, 100 lb. of ordinary foundry pig containing 2.15 per cent. silicon, 200 lb. of scrap remelt, 300 lb. old plow points and 100 lb. steel scrap.

Fig. 1 illustrates the usual type of nosing die and holder for forging the nose on all shells. Fig. 2 illustrates the chill and method used in molding and casting the die. The chill is machined to the correct shape and size, and before the mold is closed it should be given a good coating of plumbago. As soon as possible after pouring the casting should be removed from the chill, as by doing so it will be chilled deeper and harder, and also the chills last longer by not

being overheated. The chill should be made the exact size so that it should not be necessary to do any machine work whatever on the inside, and the outside being soft can be machined to suit the holder.

Dies made in the above manner give long service, as we have known cases of one die nosing over 60,000 4.5-in. Mark IX howitzer shells, which, owing to the long depth of thread at the nose, require considerable upsetting and are among the difficult shells to nose.

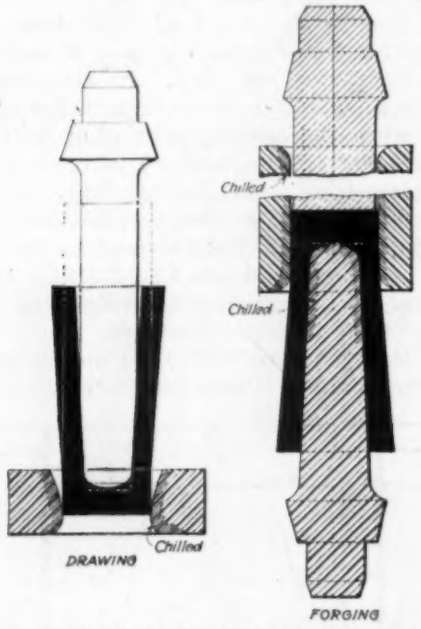


FIG. 3. FORGING AND DRAWING DIES

Fig. 3 illustrates a set of cast-iron drawing dies and punches used in forging 75-mm. shells. In drawing these shells the drawing rings have to be exact to size, and consequently, owing to wear, have to be often replaced so it can readily be seen that a very great saving is made by using chilled-iron rings for this work, as they may be cast exactly to shape and size.

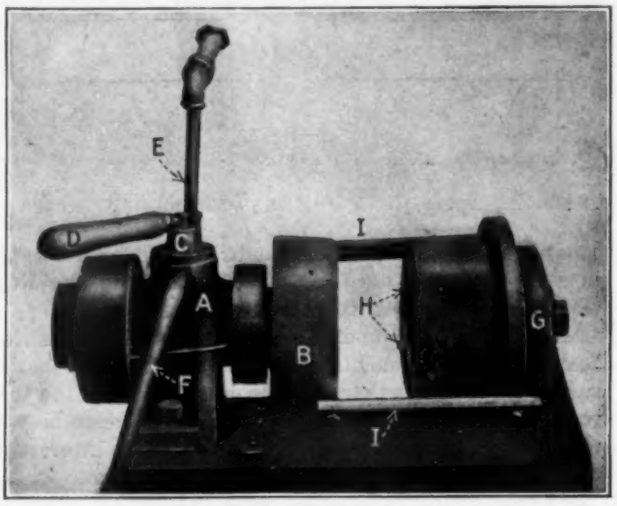
A Mold for Babbitt Hammers

SPECIAL CORRESPONDENCE

Manufacturers and machine builders who use a large number of babbitt hammer, or mauls, in their shops often find the ordinary hand mold a rather slow proposition and should be interested in the air-operated mold described in this article. In a shop where a large number of babbitt hammers are used, often several hundred being made at one time, old methods proved too slow and the air-operated mold shown in the illustration was devised. It is of simple construction and can be easily made by any one familiar with machine work.

A cast-iron base has bolted to it the cylinder *A*, which carries a piston and piston rod on one end of which is fastened one-half of the mold *B*. On the upper part of the cylinder is a two-way valve *C* operated by the handle *D*. The inlet pipe *E* comes in from the back of the valve and the exhaust pipe *F* leads from the front. On the opposite end of the base and in alignment with the cylinder is bolted a support *G* for the other half of the mold, the two halves being held in alignment when closed by the two wedge-shaped lugs *H*, which enter corresponding openings in the other half of the mold. The two straps *I* are slotted to receive bolts which hold them firmly to the outer half of the mold and prevent the half which is attached to the piston from turning. The pouring gate is above and a little back of the center so that any overflow of metal falls into a pan at the back of the mold and does not spatter on the workman.

The mold shown in the illustration is for a small hand hammer, but larger ones can readily be put on for mauls or for hammers with gas-pipe handles. The molds for the latter have an opening to receive the handle so that the metal can be poured around it.



MOLD FOR BABBITT HAMMER

In operation a movement of the handle *D* in one direction closes the molds, and throwing it in the opposite direction opens them for removal of the finished hammer.

Easy Rule for Approximating Tap-Drill Sizes

BY CHARLES JASON

I have been following the machine trade for over 25 years and not until recently have I discovered the following easily remembered rule for determining tap drill sizes for V-threads:

Divide 80 by the required pitch and let the quotient be the number of 64ths to be subtracted from the body size. In the case of a ⅜-diam. 16-pitch thread the equation would be:

$$\frac{80}{16} = 5\,\frac{3}{8} - \frac{5}{64} = \frac{19}{64}$$

and a $\frac{19}{64}$ drill is correct for a $\frac{3}{8}$ — 16 tap.

I am sending it along in the hope that it may be of use to somebody else.

[Two charges might be brought against this rule: (1) It is not sufficiently accurate to be of value on any but unimportant work, as with all pitches except 8, 10, 16 and 20 there is an awkward fraction that must be ignored, and (2) the fraction must be worked out, in which case the "rule" is far from easy of application mentally. What is the matter with memorizing the tap-drill size from 24 pitch up to and including 8? It used to be considered a part of the cub's education.—EDITOR.]

The Babson Conference on Coöperation

EDITORIAL CORRESPONDENCE

As most of our readers know, the Babson Statistical Organization has been devoting much time and energy to the problem of securing coöperation between employers and employees in the belief that this offers the only way toward a satisfactory solution of the problems which confront us. The fifth annual conference was held at Wellsley Hills, Mass., on Sept. 4, 5 and 6, at which were discussed profit-sharing, labor turnover and efficiency, the United States Employment Service, and experiences in collective bargaining and in dealing with labor unions.

WHILE there is no doubt that the interest in the subject of coöperation, and consequently in these conferences, has been considerably stimulated by the war it is interesting to note that the conferences were inaugurated in 1914, before this country had begun to realize that the European war would extend beyond its local boundaries. It is also significant that the last conference was attended by representatives of approximately 200 manufacturing concerns which employ 600,000 men and women.

The Workshop-Council Plan

William Pitt of the Irving-Pitt Co., Kansas City, Mo., told of the formation of his company's workshop-council plan, which was the outcome of a strike, and which has been in successful operation for over a year. By this plan each department of the plant elects a representative to the council, and the firm then selects a second representative from each department. There are no foremen or other company officials on the board, although the production manager, the sales manager and the shop superintendent meet with the board in order to supply any information that might aid in presenting the full facts of any disputed point to the council. They have no vote, however, nor do they argue any case for the company. The man who was the leader of the strike is now a member of this committee, and, as usual in most cases, responsibility has made him less radical than before.

The council decides questions of wages, discharge and shop government, and only in one instance has the firm considered that an unfair decision was made. This was in the case of an old man, sympathy for whom, it is believed, biased the men in their judgment. However, it was not a serious case.

The council comprises 23 members, among whom are three women, and it meets weekly on the company's time. Mr. Pitt believes that it is a success, and he hopes to have the council extend its activities into further coöperative fields, such as the buying of groceries and other necessities, the running of a lunch room for the employees, and other lines of work which can be done better by the men than by the concern. Mr. Pitt is convinced that some method of this kind is an essential to any shop, as he questions the right of the employer to arbitrarily decide what is right or wrong in his relations with the employees.

A. M. Kinsley of the Oneida Community, whose products in silverware and other articles are well known, explained the plan being used in the Community, which is known as the Cost of Living Index Plan. By it the employee receives two pay envelopes, one containing his or her wages on the basis that prevailed in 1916, and the other, known as the H. C. L., or high-cost-of-living envelope, containing an additional amount intending to represent the different between the cost of living in 1916 and the present time.

The work in the shops of the Community is done entirely by the piece. This rate was not changed, presumably on the basis that the actual work had not changed, and that any additional wage to which the employee was entitled was directly chargeable to the high cost of living, and on that account should be kept as a separate item.

The basis for the contents for the H. C. L. envelope was taken from Bradstreet's Index Numbers, these numbers being supposed to represent the comparative purchasing power of the dollar. Investigation of the increased living cost in the Community in the early part of 1916 indicated an increase of 16 per cent., and on this basis the Bradstreet Index Number was given a value of 1 per cent. for every 20 points.

In this way the wage envelope remains constant, while the contents of the H. C. L. envelope varies according to the fluctuation in living costs. These, it is needless to say, have been constantly increasing, until at the present time the H. C. L. envelope contains something over 43 per cent. of the regular wages, and is of course in addition to it.

In applying a system of this kind it should be borne in mind that local conditions have much to do with the proportion of the wages decided upon for the H. C. L. envelope. The increase made by the Oneida Community would not cover the increase cost in many localities, as this community raises its own farm produce, it delivers certified milk to its people at 10c. a quart, and rents do not cut the same figure as in other localities.

A Reactionary Note

The next speaker was Mrs. Emeline Pankhurst, the noted English suffragist, and, as often happens, althought very radical in her particular line and demanding suffrage as a democratic measure, she is a decided conservative when it comes to applying democracy to industry. She spoke against the participation of labor in the control of industry, and claimed that all labor wanted was a fair wage and more leisure than in the past. One of the opposite sex reminded her that when advocating suffrage she had always contended that women should have the vote whether they wanted it or not, as a matter of their own self-development, and

it was his opinion that the same thing is equally true in this case.

The first speaker under the subject of "Labor Turnover and Efficiency" was John Leitch, whose work for a number of years has been to bring out the latent efficiency from within the organization rather than to attempt to inject it from the outside. Mr. Leitch has found the scheme of organizing a legislative body within the plant to work very well, it being on the order of our Congress or state legislatures. The cabinet consists of the department heads, while the senate and house of representatives are elected from the shop itself. Legislation can start at any point, but must pass all the different branches before becoming a law.

This is no experiment with Mr. Leitch, as he has introduced this plan into a large number of shops of different kinds. He believes that the greatest economy that can be practiced in any plant is to save and develop the best that is in the men themselves. These committees give an opportunity for self-expression, and the employees can be led to express constructive things, which should be liberally paid for. Both Mr. Leitch and Mr. Wolf, who followed him, spoke strongly against iron-clad rules regarding methods of doing work or that restricted employees to certain fixed motions, it being their experience that nearly all of the so-called planning of this kind is neither scientific nor efficient. Encouraging individuality leads to success, while suppression of it means either decay or explosion.

Robert B. Wolf, whose work in the paper-pulp business of Berlin, N. H., and later in the Spanish River Pulp and Paper Co. of Canada is fairly well known to all progressive managers, has been commandeered by the Emergency Fleet Corporation to assist the managers of the different shipyards in preventing labor turnover.

Making the Job Interesting

In common with Mr. Leitch, Mr. Wolf has proved conclusively that it pays to bring the thinking and reasoning powers of the employees to bear on the problems connected with their work. Paper-pulp making contains many jobs that we would be apt to class as uninteresting and monotonous, but Mr. Wolf succeeded in interesting his men in every department of the plant and in securing an amount of coöperation and friendly competition which paid remarkable dividends in many ways.

The keynote of his plan is to prevent the men power becoming a part of their machines and to induce them to use their brain power in their work. This requires ingenuity on the part of the management, but it succeeded in making the work interesting and in helping the men work out new plans so well that it increased the output of the Berlin plant from 40,000 to 110,000 tons a year in less than six years, and changed the quality from the poorest to the best grade of pulp on the market.

Mr. Wolf divides the problem into three parts, the first dealing with the "raw material," the second with the "will of the men," and the third with "plant unity," or coöperation. He spares no effort to give every man as complete a knowledge of his work as possible, to make him understand his place in the organization and to show him the effect of his particular work on the output of the whole plant. By taking pains to make the men thoroughly familiar with their work and the laws that govern it, by showing progress records that are more effective when they relate to quality than to quantity, and by doing everything possible to make the man enjoy his work, Mr. Wolf has found that a man will make or suggest many improvements. In fact it became necessary to put on more draftsmen and engineers in order to carry out the practical suggestions made, all of which added to the quality and quantity of the work being turned out. It has been his experience that the men who actually do the work can give many more valuable pointers than efficiency experts who are hired from the outside.

By equipping the various machines with indicating and recording instruments, so that each man could see exactly the performance of his machine and could also note the effect of different variations on the product, he greatly increased the output of the plant and secured the coöperation of all the men. These records are not so much competitive in regard to quantity as they are to quality, and each man or each crew strives to turn out the very best product.

Men Want to Know Costs

Mr. Wolf advocates making the men familiar with the cost of the various operations, as it creates a desire to produce more material, and this is of even more importance than the quality of the equipment.

Another interesting feature of these records has been to bring the efficiency of the poorer men up to that of the best, the accomplishment of which has done much to simplify the standardizing of wages on such classes of work. This has not been done by lowering the production of the best men, but by bringing all the others up to their level.

Mr. Wolf is a great believer in democracy in the shop, and finds that by giving the men the opportunity to exercise their minds in the right direction and aiding them in every possible way a great increase in efficiency is secured. His experience has been that it is better to utilize the men's brains in this respect than to have them exercise them in finding ways of beating the boss.

An interesting phase of Mr. Wolf's talk was that while the plant at Berlin was nonunion the three large ones in Canada were completely unionized organizations, and he found no trouble whatever in introducing the same method and securing the same coöperation and efficiency. He simply had to explain his proposed plan to the organization leaders and to the men themselves to point out the advantages to all concerned, after which he experienced no difficulty in securing their coöperation. He finds that all men are human and that they will respond if they are treated right and convinced of a square deal.

Capt. Boyd Fisher spoke of the work of the United States School for Employment Managers. As is generally known the course for employment managers consists of six weeks of intensive training, and while, as Captain Fisher made it clear, it is not believed that this is a sufficient length of time to thoroughly train an employment manager, the course will do much toward rounding out the proper ideas of the men who are already partially trained along this line. These schools are open to men and women, the candidates

usually being selected by the different manufacturers in the section. The schools have had 172 graduates in the first six months of their existence, and while this number is altogether too few it is at least a substantial beginning in the right direction.

Although it is not easy to point out definite results Captain Fisher has made a careful study of the labor situation in all parts of the country, and as a result of this survey he states that there is much less turnover and absenteeism and fewer strikes and walkouts in factories that have good employment managers. He believes that next to the general manager the employmen manager is the most important official in a plant. He should be responsible for all human relations and activities and for maintaining the working force both by hiring and by training; medical and safety departments should come under his jurisdiction, and he must also look to the various sources of supply, to any mental tests that might be necessary, and the specifications for the different jobs.

He has found that both union and nonunion men are interested in taking the employment managers' course, and he advocates that special attention be paid to insuring a square deal in all cases and to endeavoring to save the other fellow's face wherever possible.

As a broad principle Captain Fisher says: "The war cannot be won with men who have reasons for discontent. Wages must be advanced in direct proportion to the decreasing purchasing power of the dollar. The application of the law of supply and demand to labor is unjust as a matter of public policy, whether it be scarce or plentiful. Efficiency as an end in itself is a mistake, as the human equation must be considered to obtain the best results. The planning department that attempts to do all the thinking for the men in the shop is wrong from every point of view."

The United States Employment Service

John B. Densmore, director of the United States Employment Service, told of the work of his department and how, after making a trip throughout the country, Mr. Babson had changed his mind and had decided that instead of printing slips for the pay envelopes of the men, they should be prepared for many of the plant managers with whom he came in contact. It is his belief that the problems of labor must be solved by much broader principles than those that have existed and that the management must be less suspicious of labor than it has been.

Mr. Densmore emphasized the necessity for capable employment managers who must be in absolute control of the various factors which belong to them. He cited one of the large special industrial centers which has been built as a result of the war and where there was enormous and constant labor turnover. This was a city of 19,000 men with no control by a broad-visioned employment manager, and the lack of all attention to matters outside of the plant led to the difficulty. He pointed out that in the main all industrial problems were concerned with the human element, and that it should be remembered that workingmen have the same feelings, the same emotions and in many cases the same aspirations as employers. He urged the consideration of the employment of women in various executive positions as well as in the shop.

Mr. Densmore particularly called attention to the fact that the present labor policy was not worked out by any Government officials but by representatives of capital, labor and the public. Before the inauguration of the existing labor board about 90 per cent. of the labor difficulties that were presented to the Government for settlement came after a strike had already occurred. This has now been reversed, so that fully 90 per cent. are caught and settled before they reach the strike stage.

Mr. Densmore outlined some of the difficulties that beset many organizations of this kind, and particularly one of such tremendous magnitude. He could give no date as to when the United States Employment Service would take over skilled labor, but he said that this would be done as soon as it could be handled. He asked for a patient and sympathetic attitude toward the employment service, which was doing the best work possible while it was being thoroughly organized and was scouring the country for men to supply the various industries. He believed that a standardized wage was necessary and that it would be put into effect in the near future.

The Advantages of Collective Bargaining

The last session was devoted to a consideration of "Experiences in Collective Bargaining and in Dealing with Labor Unions," and was opened by John S. Kent, who is president of the Brockton Shoe Manufacturers' Association, the National Association of Shoe Manufacturers, and also of a large shoe-manufacturing establishment. Others who discussed the question were R. Mahoney, general secretary of the Building Trades Employers' Association of Boston, C. H. Skinner of the Covert Gear Co., Lockport, N. Y., and Mr. Sutcliffe of the John Wood Manufacturing Co., Conshohocken, Penn. Mr. Kent outlined his 20 years' experience in dealing with the Boot and Shoe Workers' Union, and in all that time there had been no labor disturbance until this year when the radical group formed a new union. This, however, was not at all serious. He advocated the closest coöperation with the labor leaders instead of making outlaws of them, and said that his greatest criticism was that in some cases they built up a certain autocracy in the union, which failed to hold the individual men and women. He believes that every individual in the shop must be made to feel that he or she is a responsible part of the union, of the organization and of the community.

Mr. Kent spoke of the excellent work done by the State Board of Arbitration, and suggested the advisability of a national labor board to which all matters could be appealed and, if possible, settled. He does not believe that labor will ever be satisfied any more than capital, but that both will strive for better things, which is a good thing for the country. He has found that satisfactory dealings with union or any kind of labor depend largely on the attitude of the employer. The employer must consider that the other man is as human as himself, and must realize that any attempt to keep men down as workmen is largely responsible for the distrust and antagonism found. He believes in meeting his men face to face as men, and in dealing with them through their organizations. He feels that organized labor will break down class distinction and instill a better spirit into the men. This is the

result of his 20 years' experience and is therefore entitled to careful consideration.

Mr. Mahoney was confident that the only satisfactory way for the building trade to work was to deal with the men in organized groups. This industry involves so many different trades and the necessity for securing large numbers of men for short periods is so urgent that it is in a somewhat different class from other industries and must therefore be treated differently.

C. H. Skinner of the Covert Gear Manufacturing Co. told of the improved results the company has secured since forming an organization in its shop. It includes all the men and foremen and is about to become a part of the regular union. Since the organization was formed, in which an attempt was made to deal with the men as men and on what Mr. Skinner termed a "fifty-fifty basis," lost time had been reduced from 9 per cent. to less than 4 per cent., production had increased 50 per cent., and spoiled work has also been greatly reduced. The men were asked to organize so that they could be dealt with collectively.

The management endeavors to know its men thoroughly, to see that wages are raised as soon as due and to transfer men from one department to another in order to secure better results, and it has found the combination to work satisfactorily. They believe by taking an interest in the men at their work that this will be returned, as men like to feel that their work is appreciated and that they are coworkers instead of hired hands. The 55-hour week, under which they have been working, has been found too long, and this is to be reduced to 48, as the management is convinced that the output can be made at least equal to that obtained at the present time.

The whole trend of the convention was to secure better and more human relations between employer and employee, to consider all the factors that concern labor just as carefully as those that concern dividends, in the belief that by so doing much better results can be secured in almost every case. A gathering of this kind, representing as it did so many different industries and such a large number of employees, is a most hopeful sign both for present production and for the future relations between all the factors of industry, as a better understanding of each other's problems cannot fail to be beneficial to all industry as well as to the country at large.

How Would You Make This Casting?

By F. L. Sylvester

On page 510 of the *American Machinist* there is an illustrated article by M. E. Duggan under the above title in which he says that the casting "can be produced without a core box by making *A* and *C* from stock cores."

While fully agreeing with him in this respect I doubt if any foundry would have a stock core box to make a core like *C* in the illustration. Indeed I do not see how they could, for the distance from the center to the cope would vary so much in different castings and the taper of the core print would vary so much with the judgment or whim of the patternmaker as to make a stock core box out of the question.

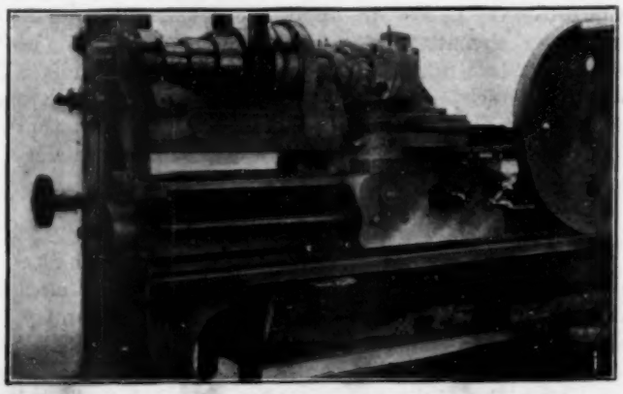
The illustration shown in the article, however, suggests the solution of the problem, for to make the pattern complete there should be a piece accompanying it similar in shape to that shown by the dotted lines marked "slab," having a semicircular notch cut out of the lower end to fit over the core. In the pattern being molded and withdrawn from the sand the core *A* is placed in position and the slab placed in the mold astride of the core and is held firmly against the end of the mold while green sand is filled in, the slab preventing the sand from getting into the mold itself. The process is then repeated at the other end of the core.

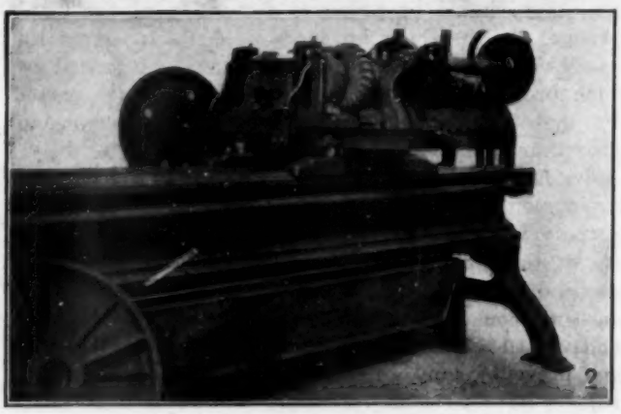
To make it as clear as possible to the molder that only a round hole is wanted in the casting it is customary, as I have observed it, to scratch around on the outer surface of the core print the complete circle of the core. As the round end of the core print itself gives one-half of this circle only the upper half is left to be scratched. The molder will then understand that whatever is above this is to be stopped off.

Lathe Made Into a Milling Machine

By Fred Fruhner

The illustrations show how I converted an old lathe into a serviceable milling machine by raising the head and building a special table and cross-slide to fasten upon the lathe carriage. No power cross-feed is provided, but the large wheel upon the cross-feed screw makes hand feeding easy, and the output of such pieces as are shown upon the table in the illustration is from 35 to 45 in 10 hours. The castings are 26 in. long by 8 in. face, and about $\frac{5}{32}$ in. of metal is removed.





FIGS. 1 AND 2. OLD LATHE CONVERTED INTO MILLING MACHINE

Electric Steel Making

BY ARTHUR V. FARR

In this article, which is an extract from a paper presented at the fifth annual meeting of the American Drop Forge Association, Buffalo, N. Y., June 21, 1918, the author briefly describes the process of making steel by the use of electricity and gives the analysis of the charge at various stages of the process and at the end of the melt.

IT WOULD seem that a word of appreciation is due the forging industry of this country for the coöperation extended to the American steel manufacturers, especially apparent since the beginning of the war. The cutting off of the steel supply from abroad made it necessary for American manufacturers to make steel which had previously been imported. The assistance rendered the steel manufacturers by the forging concerns during the first attempts at making the steels (many of them complicated alloys requiring special manufacturing methods) has proved invaluable.

We believe that this coöperation has reacted favorably on the American forging industry, enabling it to serve most effectively our military requirements, the automotive and allied industries and to render a service that has prevented any lessening of quality or production. I quote from a report that I wrote less than a year ago, following a visit to a large forging company: "They inform me that they are now getting better steel than they ever got from Germany, better in uniformity and better in physical results after heat treatment. They say that they will never go back to foreign steels." I doubt not but that this experience has been typical of a large number of forging companies during the last three years. Certain it is that the full exchange of ideas, criticisms and suggestions between forger and steel maker has enabled the forger to get a domestic source of supply and to meet the exacting requirements of the day on a better basis than ever before.

America has been known as a producer of steel in quantity, and it has been but recently that the quality element has been emphasized. The continued production of quality steels is making America's reputation symbolic of both quantity and quality.

A newcomer in the industry and a factor in the production of higher grade steels is the electric-furnace method of production. Starting with 10 electric furnaces in 1910 the growth in the number of installations has been rapid until May 1, 1918, saw 239 furnaces either in operation or in the course of construction in this country, with production for 1917 of 235,000 gross tons. The United States has not only maintained its commanding position as a producer of electric steel but the record of 1917 emphasizes this leadership. The United States and Canada are producing at the present time probably a little less than half of the world's output.

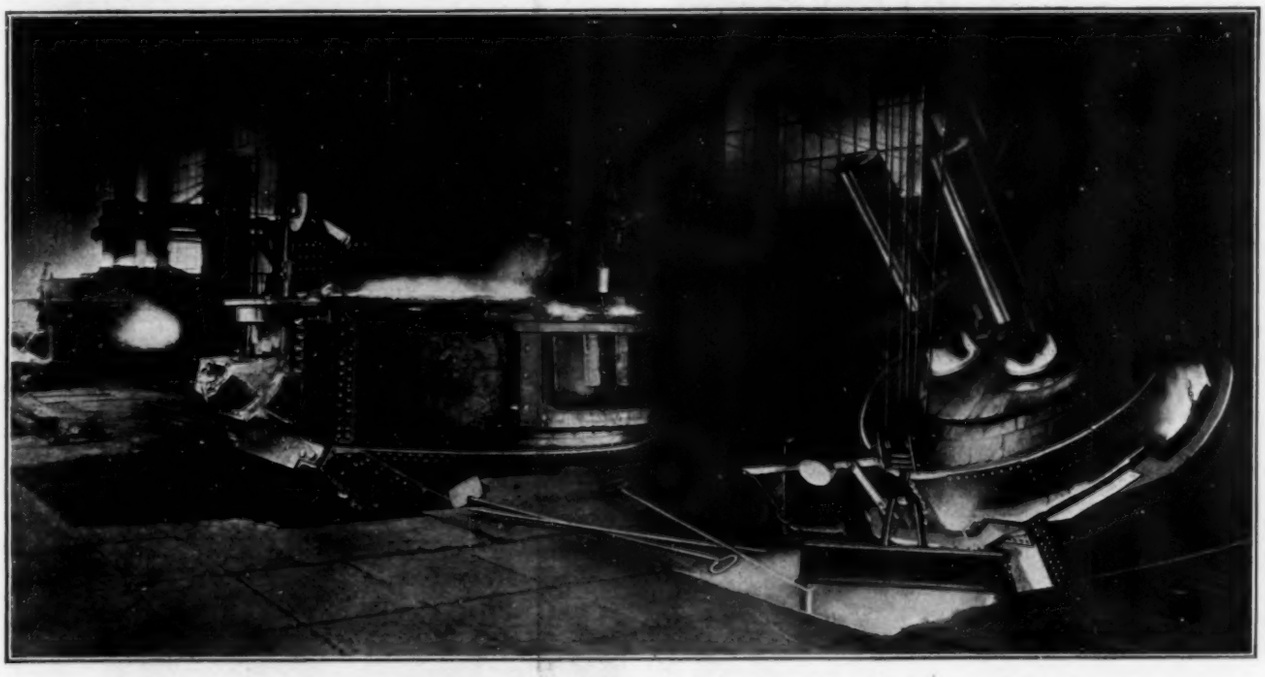


FIG. 1. BATTERY OF 6-TON ELECTRIC FURNACES

Electric steel is made either by melting a cold charge and refining it in the electric furnace, known as "cold-melt electric steel," or by refining in the electric furnace the molten charge from the open hearth or bessemer or a combination of both. This latter method is applicable especially to furnaces of 10 tons capacity and upward, the cold-melt method not having proved successful to date in the large units.

The electric furnace, as known in this country, is a metallurgical instrument for the making of steel by means of electric arcs formed between electrodes or be-

tween electrodes and the metal bath. It consists essentially of a steel tank lined with refractory materials and fitted with working doors, spout and tilting arrangements for pouring and slagging off. Carbon or graphite electrodes of suitable section are inserted through the roof or sides and can be regulated. A high-tension

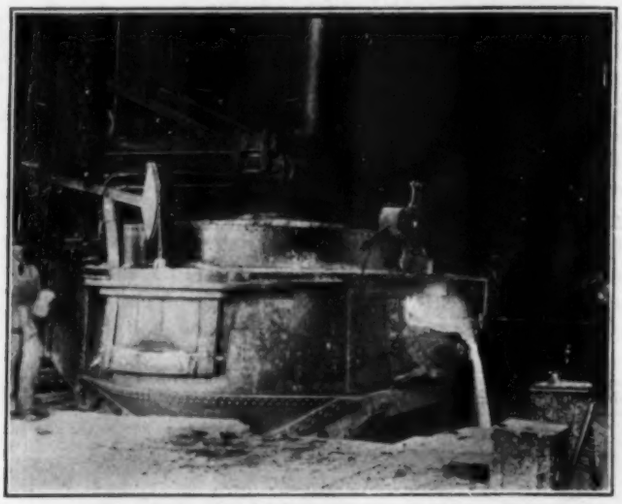


FIG. 2. SLAGGING OFF

electrical supply is brought into a transformer house adjoining the furnace and transformed down to about 100 volts for use at the electrodes.

The heat generated by the electric arcs makes possible any desired temperature up to the fusion point of the best refractory materials. The temperature in the furnace is under the control of the operator and is changed as the refinement of the steel progresses.

As an illustration of the furnace reactions that take place the following schedule is given, showing the various stages in the making of a heat of electric steel. The steel to be made was a high-carbon chrome steel used for balls for ball bearings:

FURNACE 6-TON HEROULT

11:50 A.M.—Material charged:

Boiler plate	5,980 lb.
Stampings	5,991 lb.
	11,971 lb.
Limestone	700 lb.

12:29 P.M.—Completed charging (current switched on).

3:20 P.M.—Charge melted down.

Preliminary anaylsis under black slag.

Analysis:

C.	Si.	Su.	Ph.	Mn.
0.06	0.014	0.032	0.009	0.08

Note the practical elimination of phosphorus.

3:40 P.M.—The oxidizing (black) slag is now poured and skimmed off as clean as possible to prevent rephosphorizing and to permit of adding carburizing materials. For this purpose carbon is added in the form of powdered coke, ground electrodes or other forms of pure carbon.

The deodorizing slag is now formed by additions of lime, coke and fluorspar (and for some analyses ferrosilicon). The slag changes from black to white as the metallic oxides are reduced by these deoxidizing additions and the reduced metals return to the bath. A good finishing slag is creamy white, porous and viscous After the slag becomes white, some time is necessary for the absorption of the sulphur in the bath by the slag.

The white slag disintegrates to a powder when exposed to the atmosphere and has a pronounced odor of acetylene when wet.

Further additions of recarburizing material are added as needed to meet the analysis. The further reactions are shown by the following:

3:40 P.M.—Recarburizing material added:

130 lb. ground electrodes.
25 lb. ferromanganese.

Analysis:

C.	Si.	Su.	Ph.	Mn.
0.76	0.011	0.030	0.008	0.26

To form white slag there was added:

225 lb. lime.
75 lb. powdered coke.
55 lb. fluorspar.

4:50 P.M.—

Analysis:

C.	Si.	Su.	Ph.	Mn.
0.75	0.014	0.012	0.008	0.28

Note the reduction of the sulphur content.

During the white-slag period the following alloying additions were made:

500 lb. pig iron.
80 lb. ferrosilicon.
9 lb. ferromanganese.
146 lb. 6 per cent. carbon ferrochrome.

The furnace was rotated forward to an inclined position and the charge poured into the ladle, from which in turn it was poured into molds.

5:40 P.M.—Heat poured.

Analysis:

C.	Si.	Su.	Ph.	Mn.	Cr.
0.97	0.25	0.014	0.013	0.33	0.70

Ingot weight poured	94.0 per cent.
Scull	2.7 per cent.
Loss	3.3 per cent.

Total current consumption for the heat, 4700 kw.-hr. or 710 kw.-hr. per ton.

Electric steel, because of its density, should be cast in inverted molds with refractory hot tops to prevent

FIG. 3. POURING THE INGOTS

any possibility of pipage in the body of the ingot. In the further processing of the ingot, whether in the rolling mill or forge, special precautions should be taken in the heating, in the reduction of the metal and in the cooling.

In this paper no attempt has been made to compare at length the relative merits of open-hearth and electric steel. I do not believe that it is necessary because results in service, day in and day out, have thoroughly established the superiority of electric steel. Individual laboratory tests do not always square with results in the field, but it is the latter that are wanted. One forger expressed his experience tersely as follows: "We can get physical properties much easier with electric steel." Ten years of experience indicate that electric steel is equal to crucible steel and superior to open hearth.

The rare purity of the heat derived from the electric

FIG. 4. BENDING AND TWISTING TESTS OF CHROME-VANADIUM "COLD-MELT" ELECTRIC STEEL

arc, combined with definite control of the slag in a neutral atmosphere, explains in part the superiority of electric steel. Commenting on this recently Dr. H. M. Howe stated that "in the open-hearth process you have such atmosphere and slag conditions as you can get, and in the electric you have such atmosphere and slag conditions as you desire."

The ultimate consumer in a large measure is the court of last resort, determining what steels shall be used in the manufacture of his product. It is the ultimate consumer who realizes that the best materials obtainable are none too good, and the drop-forger, knowing this and that the difference in cost of steels is small compared with the labor, forging equipment

Cutting an Irregular Recess on the Milling Machine

By Ellsworth Sheldon

The cam-cutting fixture shown in the illustration is the regular attachment designed and built by the Garvin Machine Co. for cutting face and peripheral cams up to 12 in. in diameter. Many of these fixtures are in constant service in the Garvin shops, the work on which the one in the illustration is engaged being the routing of the recess in the spindle of the Garvin index head.

The fixture, which may be used on any standard form of milling machine, consists primarily of a base ribbed to fit in the machine table and flanged at the ends to provide for clamping it down; a swinging lever fulcrumed at one end in a bracket which is bolted to the base casting; a wormgear-driven spindle mounted in the free end of the lever, and means for rotating this spindle either by hand or power.

Ample bearing surface both in length and diameter at the fulcrum end and a sliding bearing in the bracket at the free end of the lever provide against side play and allow free movement without vibration.

Construction of the Spindle, Chuck and Faceplate

The spindle is hollow, thus accommodating long pieces which may require machining operations upon their ends. The inner end of the spindle is provided with a chuck to hold the work while the outer end has a faceplate to which is fastened the master form which determines the shape to be produced by the milling cutter.

In the illustration the work is held in a special chuck *A* designed to hold it by the wormgear, which in this case is integral with the spindle, and the master form *B* is several times larger than the finished recess. A small bracket *C*, Fig. 1, adjustable in a direction parallel with the spindle carries a vertically-adjustable member *D*, which in turn carries the roll on which the master form bears.

As the spindle carrying the work is revolved the master form bearing upon the stationary roll causes the lever to rise and fall in accordance with the contour of the master which will thus be reproduced in shape on whatever material is in the path of the milling cutter, the principle being not unlike that of a Blanchard lathe. A weight *E* suspended from an extension of the swinging lever serves to keep the master form at all times in contact with its roller, despite any tendency of the milling cutter to lift the work. This weight, which is the same as the ordinary form of scale weight, may be increased or diminished to suit the case in hand.

Size of Master Form

It is of course desirable to keep the size of the master form above a certain minimum to avoid harsh movements and to reduce possible errors, and when, as in the case in small work, the master is several times larger than the work, a peculiar complication is introduced. A few moments' reflection will make it clear to the mechanical mind that so long as the master form and the work are of the same size and the follower roll and the milling cutter are also of the same size, the work will be an exact reproduction of the master form, but if any one factor is varied there will be deviation from the true form in the result.

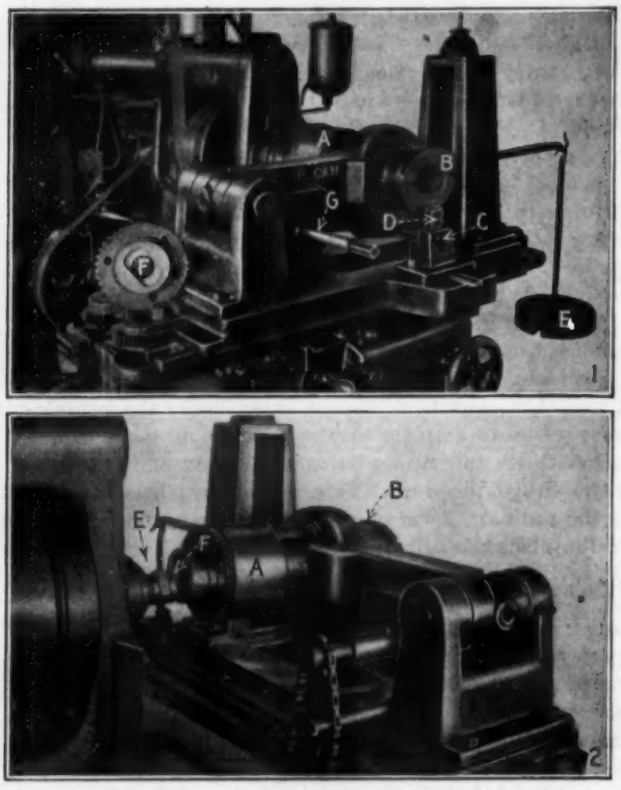
It would be a long and tedious process to calculate the exact shape of a master form under such conditions, and the calculation is unnecessary, for the problem is solved with ease and certainty by the machine itself. A cam or, in the case of the work illustrated, a recess is made by hand to the exact size and shape of the desired product and attached to the faceplate at the outer end and after expense put upon forgings, finds that it is economy to use high-grade electric steel.

of the fixture spindle. A follower roll of the same size as the cutter to be used on the finished product is then placed in position on part *D*. A suitable piece of material is now fastened to the inner, or work, end of the fixture spindle, while in the milling-machine spindle is placed an end mill of the same diameter as the follower rool which is to be used in connection with the master form.

The machine is now set to work, and it should be obvious that the master form produced under these circumstances will, with the conditions reversed, reproduce the original regardless of the difference in size or shape.

Some of the master forms are so different from the shape of the cams they produce that it appears incredible there should be any relation between them. By comparing the master form at *B* with the finished work *F*, Fig. 1, it will be observed that the corners in the work are much more accentuated, while the straight sides appear in the master as decided curves.

The fixture can be operated by hand with a crank on the shaft *G*, Fig. 1, or by power with chain drive as



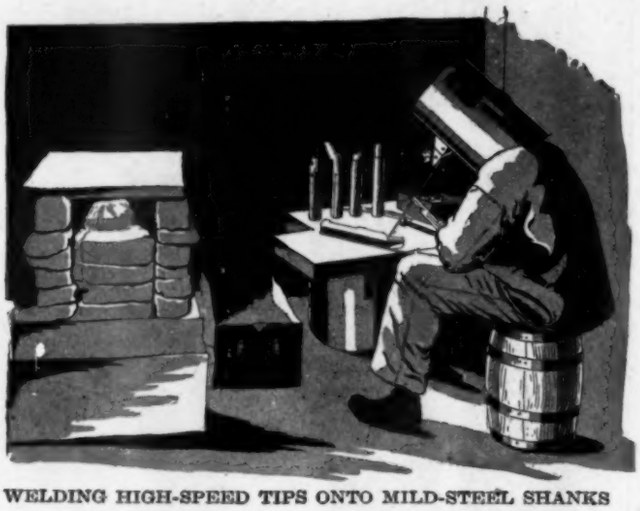
FIGS. 1 AND 2. CAM-CUTTING FIXTURE
Fig. 1—Cam-cutting fixture set up for cutting recess. Fig. 2—Showing work in position

shown in Fig. 2. By extending the shaft of the regular feeding mechanism the universal joint of the latter may be placed directly on the operating shaft of the fixture in place of the sprocket in Fig. 2.

The cut is made with an end mill and the feed is straight in; thus when the size is once established and the table and saddle stops are set, the operator is able to produce the pieces in quantity without much chance for variation. With the machine fitted with power feed, as shown in the cut, a boy can keep several machines in operation.

Arc-Welding High-Speed Tool Tips

Arc-welding was brought prominently before the public by its use in restoring the broken engine castings of the interned German ships a short time ago. When breaking these castings the Germans thought they could not be repaired and that it would require a year or more to replace them. But even before the ships could be otherwise overhauled and made ready for transport service all the broken castings had been repaired and were as good as new. This achievement impressed the value of arc-welding on the minds of many shop managers, and in several plants castings and other parts of apparatus which in the past would have been



WELDING HIGH-SPEED TIPS ONTO MILD-STEEL SHANKS

scrapped as hopelessly damaged are now perfectly restored by the arc-welding process at small cost and great saving of time.

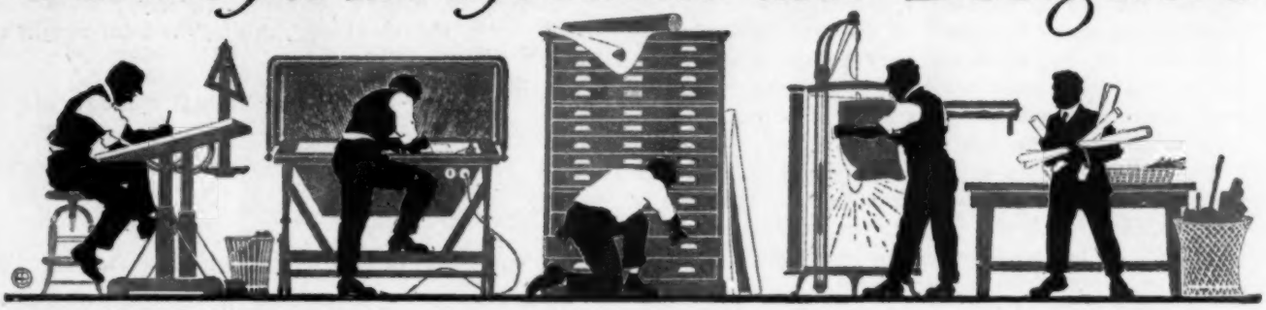
One large manufacturer working on munitions has installed a Westinghouse arc-welding equipment for the sole purpose of making tools for turning shells. Ordinarily these tools are made from high-speed steel and cost about $12 each. This manufacturer uses high-speed steel for the tip of the tool only, welding it to a shank of carbon or machine-steel, and in this manner the tools are produced at a cost of $2 to $4.

For several weeks this plant has been turning out 240 welded tools a day, the men working in shifts of four, which is the capacity of this outfit.

The equipment consists of a 500-amp. arc-welding motor generator with standard control panel, and three outlet panels for metal-electrode welding and one special outlet panel for the use of either metal or graphite electrodes. The special panel is intended to take care of special filling or cutting processes that may be necessary, but ordinarily it is used in the same manner as other panels for making tools. These panels are distributed about the shops at advantageous points.

For toolmaking, which involves the hardest grades of steel, a preheating oven is used, not because it is necessary for making a perfect weld, but because otherwise the hard steel is likely to crack from unequal cooling and also because preheating makes it easier to finish the tool after the welding process has been completed. For ordinary arc-welding operations the preheating oven is never used.

Series for Draftsmen and Designers



Relation Between Force, Energy and Work

By DEXTER S. KIMBALL
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While problems of design involving the consideration of force alone are usually well understood by most designers, certain classes of problems that involve the consideration of energy and work or combinations of energy and force are not always so well understood. This appears often in discussions concerning the blow a pile-driver hammer or a steam hammer can deliver.

WHEN a force or a system of forces acts upon a machine part that is restrained from moving by reason of its connection with other parts, the effect of the force or forces is resisted by internal stresses set up within the member acted upon, and the problem of design in such cases is simply to proportion the dimensions of the member so that it will not break or be unduly distorted under the action of the external forces. Design of this character involves, therefore, simply a balancing of forces, and the problems of energy or work do not appear. Even in the design of parts that are to be in motion the usual procedure is to assume that the parts are rigidly held by the reactive forces and thus to determine the internal stresses. Occasionally, of course, the stresses due to the motion of the part itself must be considered as in the "whipping" action of a fast-running engine connecting-rod.

If the body acted upon is free to move, the forces acting may perform work upon it which may or may not be recoverable. The measure of work is the product of the force acting and the distance through which it moves. Suppose that the hammer of a pile driver weighing 3000 lb. is dragged along the ground for a distance of 20 ft. Suppose further that the surface over which it moves is such that the coefficient of friction is 0.5, so that the resisting force of friction which must be overcome is $3000 \times 0.5 = 1500$ lb. The work done in moving the hammer is $1500 \times 20 = 30{,}000$ ft.-lb., and this work is all lost in the frictional resistance disappearing as heat.

Suppose, however, that the hammer is lifted slowly 20 ft. vertically, the friction in the guides being negligible. The hammer now possesses $3000 \times 20 = 60{,}000$ ft.-lb. of potential energy with reference to the point from which it was lifted, and if released it will give out this amount of energy in the form of work before reaching the original position. It might be employed, for instance, to operate some machine doing useful work in the same way as clock weights operate the mechanisms of such instruments.

If, however, the hammer is permitted to fall freely and strike the head of a pile at the point from which it was lifted the force of the blow which it will strike will depend upon how far the pile is driven. If the pile moves 1 ft. the average force that will be applied to it will be $\frac{60{,}000}{1 \text{ ft.}} = 60{,}000$ lb. If it moves 2 ft. the average force will be 30,000 lb., and so on. If the pile rests on very hard ground, so that the motion is very small, the blow is correspondingly very great. Theoretically, if the motion is zero, the force of the blow is infinite; but this can never occur, as absolutely rigid bodies are not known.

If a body is moving in a straight line or in an arc so great that every portion of it can be considered as moving at the same rate, it possesses what is defined as kinetic energy. If the weight of the body is W and its velocity in feet per second is v the measure of kinetic energy in foot-pounds is given by the expression $\frac{Wv^2}{64.4}$. This expression gives the number of foot-pounds of work that has been expended upon the body to bring it up to the velocity v and also the amount of work in foot-pounds that the body will give out in being brought to rest. If the velocity of the body is changed to some other value v_1 the new value of its kinetic energy will be $\frac{Wv_1^2}{64.4}$ and the difference between this value and the original kinetic energy will be the work that has been expended to increase the velocity, or the work that the body has given out in decreasing its velocity, depending on whether v_1 is greater or less than v.

If the body is rotating about an axis it is clear that the velocity of different parts of the body will be different and the value of the kinetic energy which it possesses will depend on the shape of the body and its distribution around the axis of rotation. One of

the most common problems of this kind is found in designing flywheels. Except in refined calculations for wheels that are to be kept within narrow limits of variation of speed the effect of the hub and arms is neglected. If the arms are very heavy as compared to the rim they must often be considered. But in such machines as punching machines it is usually sufficient to consider the rim alone. If, again, the radial width of the rim is small compared to its distance from the center the error in assuming that the velocity of all parts of the rim is uniform and equal to the velocity of its mean circumference is not great and this is the usual procedure in such cases.

Let it be assumed that the punching machine, Fig. 1, is to punch $\frac{3}{4}$-in. holes in $\frac{1}{2}$-in. steel plates. The mean diameter of the flywheel, for convenience, is found to be 42 in. and its rotative velocity from other considerations is fixed at 180 r.p.m. It is required to find the cross-section of the flywheel rim. The effect of the arms is to be neglected, and for simplicity also the effect of the belt pull during the operation of punching will be disregarded. In general this last factor is a small one as compared to the action of the flywheel. Experiment has shown that the pressure curve of a punch passing through plates of moderate thickness is similar to that shown in Fig. 2, the maximum pressure occurring at about one-third of the way through the plate. The value of this maximum pressure is found by multiplying the area in shear by the shearing strength of the plate. It is found in actual practice that the shearing strength of a plate in punching is somewhat higher than that found in simple shear and may be taken as 60,000 lb. per square inch for mild-steel plates. In the example taken, therefore, the maximum ordinate m of the pressure curve will represent a force $P = \pi \frac{3}{4} \times \frac{1}{2} \times 60{,}000 = 70{,}800$ lb. This is the maximum force that will be brought upon the frame tending to break it open, and it also will form the basis for the design of the several machine parts, gears, etc.

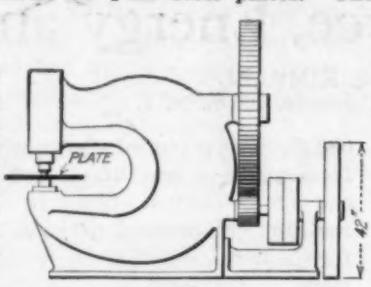


FIG. 1

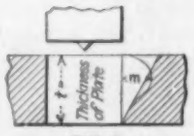


FIG. 2

FIG. 1 AND 2. DIAGRAMS OF MACHINE AND PLATE

The average punching pressure may be safely taken as one-half the maximum pressure, and the work in foot pounds performed in punching the hole will be

$$\frac{70{,}800}{2} \times \frac{1}{2} \times \frac{1}{12} = 1480 \text{ ft. lb.}$$

If the mechanical efficiency of the machine is 85 per cent., the flywheel must supply $\frac{1480}{0.85} = 1750$ ft. lb. of energy while the punch is passing through the plate. The variation in the velocity of the wheel may be 10 per cent. without excessive slipping and consequent noise on the part of the belt. The number of revolutions of the wheel is 180 per minute, or 3 per second, hence the linear velocity of the rim in ft. per sec. will be

$$v_1 = \frac{2 \times \pi \times 42 + 3}{12} = 33 \text{ ft. per second, whence}$$

$v_2 = 33 \times .90 = 30$ ft. per second (nearly). Then from the theory of kinetic energy, calling the total weight of the rim W

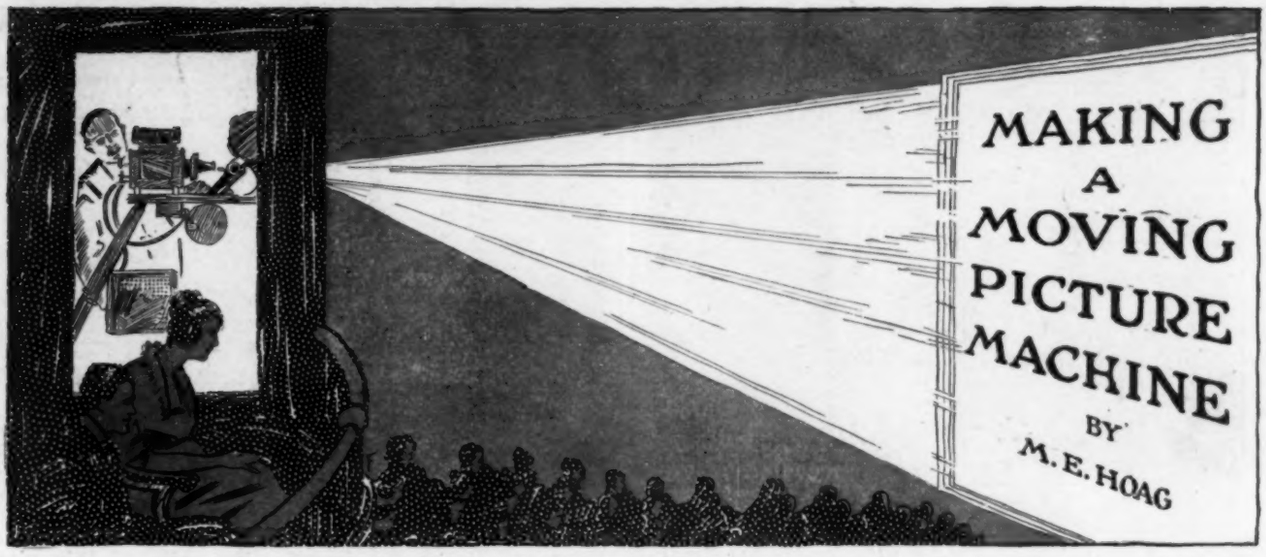
$$\frac{W \times 33^2}{64.4} - \frac{W \times 30^2}{64.4} = 1740 \text{ ft. pounds;}$$

$$\text{or } \frac{W(33^2 - 30^2)}{64.4} = 1740;$$

$$\text{or } W = \frac{1740 \times 64.4}{33^2 - 30^2} = 590 \text{ lb.}$$

One cubic inch of cast iron weighs 0.26 lb., therefore there will be $\frac{590}{0.26} = 2270$ cu. in. in the rim. The mean circumference of the rim $= 132$ in., hence the cross-section will be $\frac{2270}{132} = 17.2$ sq. in., which would correspond to a rim section $3\frac{1}{2}$ in. wide and about 5 in. deep.

It should be carefully noted that in this and similar problems there are two distinct ideas to be kept in mind, namely, the question of the maximum *force* and the question of the maximum *work* that is to be performed. Both will vary with the material punched. If the plate to be punched is exceedingly hard the force may be so great as to break the machine, or if the machine parts are strong enough to resist this maximum force the energy in the flywheel may not be sufficient to carry the punch through the plate, or if it is able to do so the reduction in velocity may be so great as to be undesirable. And it is important to keep in mind that moving bodies possess energy that can be given up to do work. This may be done by a small force acting through a long distance or by a great force acting through a small distance, but in any cause the two factors cannot be separated.



III. The Light Shutter

This article describes and illustrates the shutter and its operation, and some simple dies for bending and forming intricate pieces that do not warrant the use of compound bending dies because of the prohibitive tool cost.

AS PREVIOUSLY stated the number of images thrown on the screen must be at least 16 per second in order to give the impression of continuous motion. Beyond this speed the human eye will not differentiate between successive impressions, although at this speed there is still a tendency for the eye to get the impression of flicker, or to distinguish between the light and the dark periods which correspond to the rest and movement periods of the film. To overcome this it is necessary to do one of two things, either increase the number of images per second or break up the light period into more than 16 per second. As the former would require the use of double the amount of film for one thing and would also be objectionable for other reasons, the correct solution seems to be to break up the light period into 32 flashes per second. This gives the picture on the screen steadiness and freedom from flicker. Here again we come to another point that Mr. Victor has evidently solved in a satisfactory manner. If a single-bladed shutter is used, the blade, in order to give the right period of darkness during the movement of the film, would have to be speeded up to 32 revolutions per minute and the width of the blade would be such that the second flash would give too long a period of darkness and the quality of the picture would be little improved over 16 flashes or interruptions per second. So a two-bladed shutter is used, on which the second blade is much narrower than the first. Such a blade is shown in detail in Fig. 17.

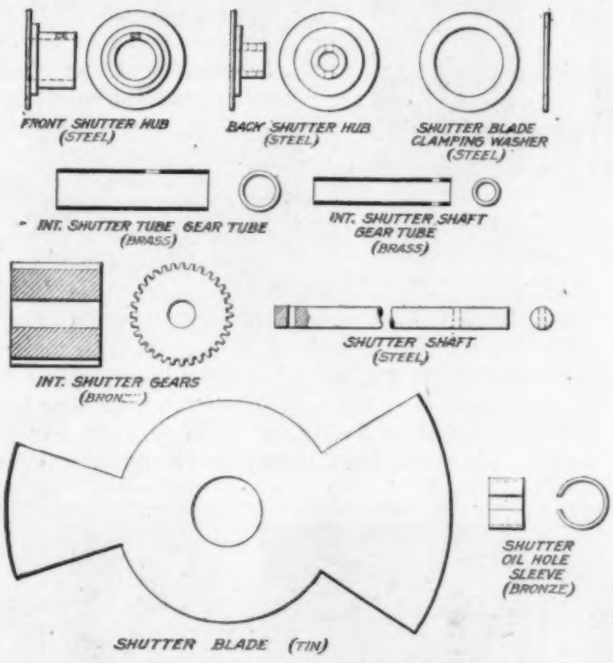
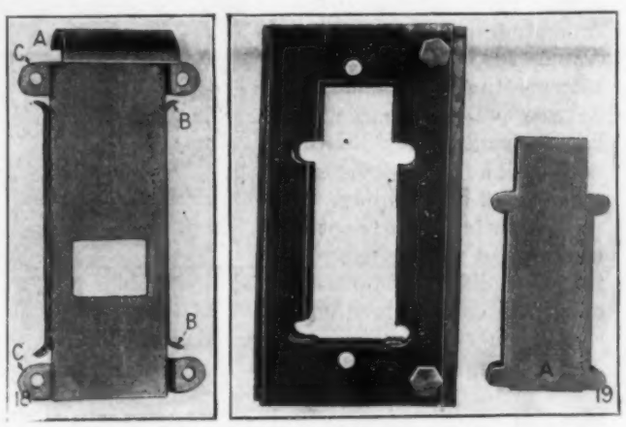
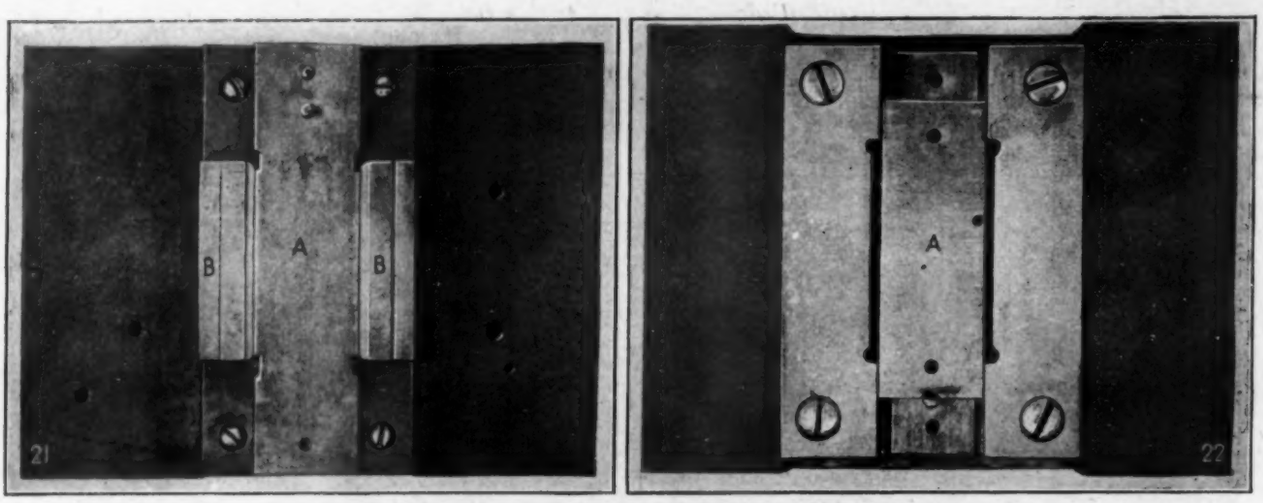

FRONT SHUTTER HUB (STEEL)
BACK SHUTTER HUB (STEEL)
SHUTTER BLADE CLAMPING WASHER (STEEL)
INT. SHUTTER TUBE GEAR TUBE (BRASS)
INT. SHUTTER SHAFT GEAR TUBE (BRASS)
INT. SHUTTER GEARS (BRONZE)
SHUTTER SHAFT (STEEL)
SHUTTER OIL HOLE SLEEVE (BRONZE)
SHUTTER BLADE (TIN)

FIG. 17. DETAILS OF SHUTTER



FIGS. 18 AND 19. THE FILM GUIDE AND BLANKING TOOLS

This blade would be satisfactory if it had to cover a very small, round aperture, but as the window, or frame, through which the light passes is rectangular in shape and about an inch across, it can be readily seen that the film would be in motion both before and after the edges of the shutter blade had passed the edges of the frame. To overcome this difficulty and still keep



FIGS. 21 AND 22. FORMING DIES FOR BENDING UP THE SIDES OF THE FILM GUIDE

the speed of the shutter down to a reasonable number of revolutions per minute Mr. Victor has devised a shutter consisting of two double blades like the one shown, but rotating in opposite directions and approaching from the sides of the frame and receding from its center equally, thus giving a very smooth picture with a greater period of illumination than would be possible with a shutter of any other type. This is one reason the Victor Animatograph can be operated successfully with nitrogen-tungsten lamps or with an arc lamp of lower candlepower than is possible with some other types of machines.

The shutter itself is not complicated in construction nor difficult to machine, as can be readily seen from the drawings. The blades are made from sheet metal painted black, and each is mounted on a hub and carries a bronze pinion. These pinions are so connected with a train of gears that the shutters operate in opposite directions.

The piece shown in Fig. 18 contains the aperture through which the light passes from the picture on the film to the screen and has been referred to in these articles as the frame. The sides of this piece are bent up at right angles to form a guide for the film as it passes across the aperture. One end is also curled up so as to present a smooth surface and gradual curve to the film as it passes from the reel above the machine. The sides are also cut free and curled outward for a short distance at each end for the same reason, as any sharp corner would scratch the film or catch and break it.

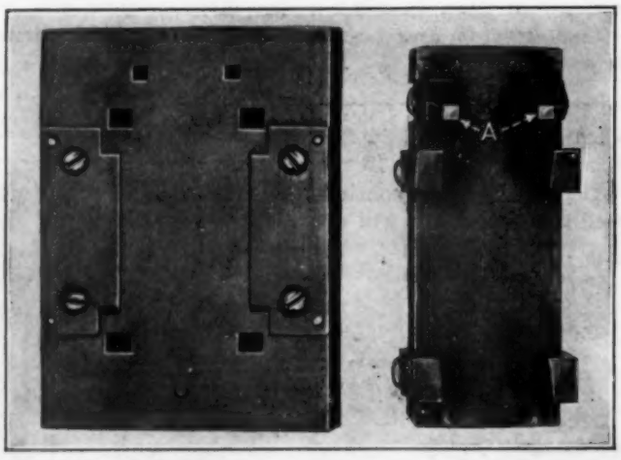
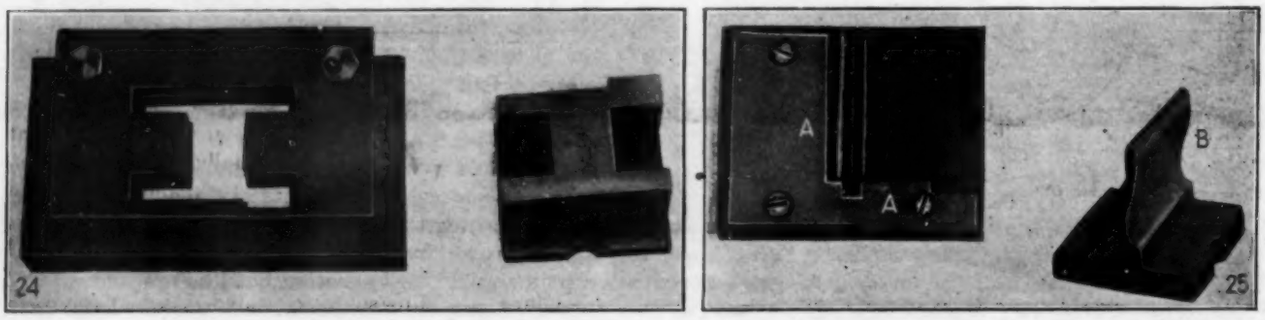


FIG. 20. PIERCING AND SHEARING TOOLS FOR FILM GUIDE

By reason of the small number of these pieces required, compound bending dies would be too expensive, and as hand work would also be expensive and not sufficiently accurate, a series of simple dies has been evolved.

The first die is a blanking die, shown in Fig. 19, which blanks out the piece to the shape shown by the punch *A*. The next punch and die cut out a square notch on each side, as seen at *A*, Fig. 18, with the two small punches *A*, Fig. 20. The other four punches cut the sides loose from the ears and at the same time turn them out as seen at *B*, Fig. 18. The next die, Fig. 21, bends up the sides. The four notches receive the portions



FIGS. 24 AND 25. DIES FOR BLANKING AND FORMING THE FILM CONTACT SPRING

curled up by the die in the previous operation. The central portion *A* of the die is backed by springs and recedes as the punch descends and presses the piece down between the blocks *B*, and so bends up the straight side pieces. The next test of dies shown in Fig. 22 form the four ears *C*, Fig. 18, in practically the same way. The piece is placed across the block *A*, Fig. 22, and as the punch comes down it bends the ears up and over. The large curled portion seen at the top of Fig. 18, is bent by hand, as all that is required is a smooth surface for the film to pass over. The aperture is cut out with a punch and die.

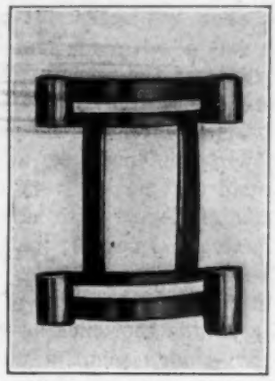
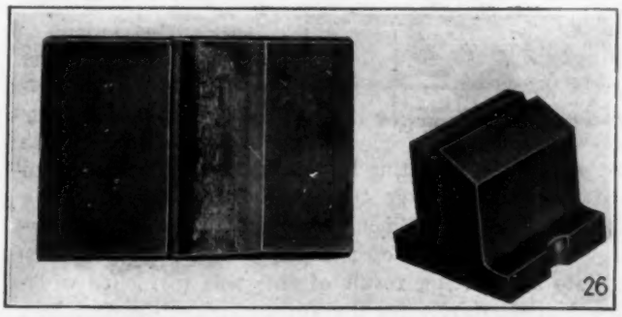
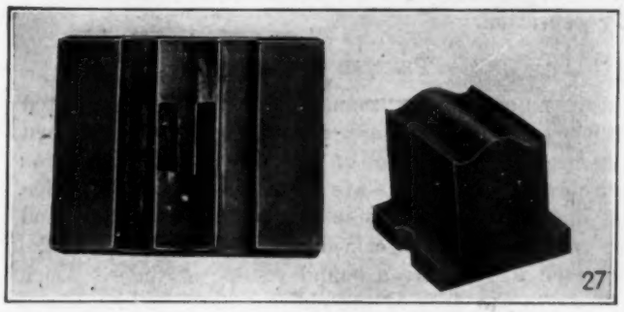


FIG. 23. FILM CONTACT SPRING

The piece shown in Fig. 23 presses against the film and keeps it in contact with the small film sprocket which was described in a previous article. This piece is first blanked out with the punch and die shown





FIGS. 26 AND 27. SECOND AND THIRD FORMING TOOLS FOR FILM CONTACT SPRING

in Fig. 24, piercing dies being used afterward to punch the two long slots and the central opening. The next operation is starting the curl on the four ends. This is done in two operations with the punch and die seen in Fig. 25, first one side and then the other being presented to the die. The plates *A* on the die act as gages for locating. The punch *B* is made in rather a peculiar shape in order to give clearance for the portion of the plate already bent when the second side is bent up; otherwise it would buckle the piece in the center. The final curl is given to the ends of the piece by the punch and die shown in Fig. 26. A piece of drill rod of correct diameter is placed in the semicircular groove already formed and the piece is laid in the groove in the die, and as the punch comes down it curls the stock around the wire mandrel. The second pair of ends are then treated in the same way, after which the curve is given to the central portion of the piece by the punch and dies seen in Fig. 27. This covers most of the parts which require tools of unusual construction. The other parts are made on lathes, shapers, milling machines, etc., in ways that would suggest themselves to any first-class mechanic and do not require description here.

Efficiency of the Wrong Brand

BY HI SIBLEY

Take care how you play with efficiency—its loaded! In bungling hands this powerful field piece of industry may cause a horrible slaughter of the innocents and be an aid instead of a hindrance to the common enemy, General von Overhead.

Particularly is this true when fired point blank at the individual. In war-time striving to eliminate lost motion and take up the slack, efficiency has been handled downright carelessly, and instead of shooting holes in production costs frequently has backfired and spattered up plant personnel. Why do factory managers, some of them at least, persist in using this handy weapon so unintelligently? Constantly prodding the shop employee with personal-efficiency propaganda is akin to waving the well-known red shirt in front of a bull. A surfeit of theoretical efficiency has soured many a well-meant campaign.

One wonders why a more intimate knowledge of the human element is not considered. Our man at the bench or lathe is a thoroughly human chap, and when you get to know him a mighty likable one, but in temperament he is pretty much a youngster and should be approached as such. He is prone to be a bit skeptical when a new idea that he does not understand thoroughly is forced upon him. The case is like a South Sea Island missionary bearing down on a native with a Bible in one hand and a pair of pants in the other. The missionary knows they are good for his subject, one to cover his soul and the other his shanks, and thus raise him to a higher plane in the world. But John G. Cannibal is apathetic; his mind is working along lines of more tangible and immediate welfare. He is thinking, "What a succulent pot roast this bird would make!" Likewise the average shop employee is more interested in immediate pot roasts than in future glorification. He does not enthuse when told that by becoming more efficient individually he will help the business expand so that in say a couple of years an extra foreman will be needed and he will be It. And yet that is precisely the fundamental lure offered by some benighted factory managers.

A production chief plans an efficiency campaign and becomes all enthused over it, bubbles over with the idea and succeeds in conveying a measure of his enthusi-

asm to his superintendents, who in turn transmit it down to the shopman in diminishing degrees. But by the time it reaches the man in overalls it is lukewarm and has lost its savor. Some industrial heads attempt to overcome this by having banquets for the men, "get-together" dinners and "love feasts" they call them, a producer-direct-to-consumer idea.

But often these overshoot the mark, because although the meal has a certain warming influence and tends to put the men in a receptive state of mind, too brazen attempts are made to introduce "Mickey Finn" efficiency powders into the food. There will be a series of efficiency talks, dry and tedious, which, instead of making a favorable impression, amount to a mild sandbagging. Moreover there is nothing that will cause a foreman or superintendent to lose the respect of his men like a halting, mumbly, diffident after-dinner talk with no more force to it than a hot breeze from a prairie. And it so happens that the most efficient department heads invariably are the most miserable public speakers. Why will they consent to appear at a disadvantage before their men?

Effects of Shop Dinners

These shop dinners have immeasurable value if the speakers have sufficient personal magnetism and gift of oratory to get under the hides of their listeners. There comes to mind one genial, two-fisted, straight-from-the-shoulder factory manager who employed intelligent tactics to leave an impression. Efforts were to be made in this particular plant for a record month's production, and a banquet to superintendents and foremen was arranged as a self-starter. Each guest found at his plate a short length of rope and a piece of wood with a sharp nail in the end of it. No explanation of these accessories was made throughout the dinner, and naturally the men grew curious about them.

After the cigars were passed the factory manager arose.

"Men," he bellowed, "this month's schedule calls for 5000 completed jobs. That will be a record. We have the equipment, material and men to produce more than that. But it will require the full coöperation of your men.

"You will get the best results by leading them. That is what this rope is for. But if a man won't be led, try the prod. If, however, he can be neither led nor driven, take the rope and hang him to the nearest tree and go out after another man. Do you get me? Are we going to hit that 5000 mark?"

And following their unanimous cries of "Sure thing!" he thanked them and sat down. They liked that talk, and they liked that factory manager, because in his dealings with them he was brief, direct and talked in a language they could understand. Had he, on the other hand, delivered a long dissertation on the virtues of personal efficiency the thoughts of nine out of ten of them would probably have been wool-gathering in distant pastures.

Say what one will to the contrary, results are and always will be accomplished most quickly on a personal-contact basis, and the man who can project his personality farthest is the man who gets the greatest coöperation. Some years ago the head of one of the oldest and largest manufacturing institutions in the country celebrated his eightieth birthday by a reception for shop employees. It was a very impressive affair. He was a self-made man, and it was patent from the attitude of the men in greeting him that a warm personal friendship existed between them. In his manufacturing career of 50 years he had made a point of knowing his employees as intimately as possible, and it is said that he was very circumspect in preaching personal efficiency. He accomplished that by the more effective and popular method of setting an example for others to follow.

Efficiency campaigns of the flat-wheel type occasionally invade the office as well as the shop. In one efficiency-ridden plant a well-meaning but inexperienced office manager sought to attain the millennium by a wholesale carting out of dead-head operations, noises and what not. He had neither the personality nor the popularity to inspire anyone, and he launched his campaign with the same tact and vigor that a man uses in beating a carpet.

First he issued an office rule book, which was designed to regulate pretty nearly everything in an office employee's life, including his respiration. It was couched in dictatorial language that was more applicable to a penal institution and included a series of minor punishments for infraction of the rules. Naturally the immediate and lasting result of this was to incure widespread unpopularity for the author and subsequent lack of coöperation.

Printed Tickets

How many factory managers really think printed efficiency talks do any appreciable good? One concern attaches a printed ticket of this sort to the time cards each pay period. There are 52 in the series—52 golden platitudes wrought by some armchair blacksmith. And the employees are informed that those who save the entire 52 will receive a bound volume of them! Hark ye back to the days of the old-fashioned Sunday-school when we were given a copy of "The Pilgrim's Progress" for a year's perfect attendance. Seriously now, isn't that just a bit ridiculous?

There are scores of other instances where efficiency ammunition has been woefully misapplied, but none should criticise who cannot suggest a remedy. Using efficiency propaganda as a mallet is worse than none at all. It is the subcutaneous injection that does the work. And to accomplish this a more thorough understanding of the individual is imperative. We do not like to be preached at nor lectured. We are not so keen for efficiency for efficiency's sake alone, but we automatically follow the example, more or less conscientiously, of the man we like and respect. There are great establishments in this country where the personality of a single man has inspired the entire organization. They have built their prestige on that alone.

Fighting with Fire in Ancient Times

By H. H. MANCHESTER

In ancient days fire was a formidable weapon of war and novel means are recorded to show the manner of its use. The Chinese, Greeks, Romans and even medieval nations employed it with great success against their less well-equipped enemies. The development of gunpowder disposed of fire as a means of fighting until the present war when recourse was had to its potency for destruction. Some of the illustrations taken from old plates are interesting and instructive.

THE war is not only developing new instruments of warfare, but is reviving methods long supposed to have been superseded. One of these revived methods is the use of fire. The earliest use of fire in combat is prehistoric, and probably began when savages learned that firebrands would drive away wild animals and tribes less accustomed to it than themselves. The employment of fire as a distinct means of warfare may be said to have begun when materials were discovered which were more inflammable than wood.

The earliest representation of such fire used in war is shown in an Assyrian bas-relief, Fig. 1, found at Nineveh, which is sometimes dated as early as 800 B.C. It depicts burning fagots being thrown from the walls upon the besiegers, and judging from other evidence these were bundles of tinder and perhaps other inflammable material that had been soaked in bitumen, which was found in many places in western Asia. Several interesting instances of the use of fire by the Greeks have been recorded. In 429 B.C. the Peloponnesians cast brands impregnated with pitch and sulphur into Platea and caused so great a fire that it could only be extinguished by a downpour of rain. A still more striking example took place at Delium in 424 B.C. "The Bœotians," according to Thucydides, "sawed in two and hollowed out a great tree which they joined together again very exactly like a flute, and suspended a vessel by chains at the end of the beam. The iron mouth of a bellows, directed downward into the vessel, was attached to the beam, of which a great part was stuff overlaid with iron. . . . They applied a large bellows to their own end of the beam and blew through it. The blast, prevented from escaping, passed into the vessel which contained burning coals and sulphur and pitch; these made a huge flame and set fire to the rampart so that no one could remain upon it. The garrison took flight and the fort was taken." At the siege of Syracuse in 413 B.C. the Syracusians succeeding in setting fire to the engines which were drawn up before the walls, and made an unsuccessful attempt to send a burning merchant ship down upon the Athenian fleet. The military writer Æneas, about 350 B.C., recommended that pine and tow be soaked in pitch sulphur and incense and stowed away in egg-shaped wooden casks ready to be lighted and thrown on the enemy's decks.

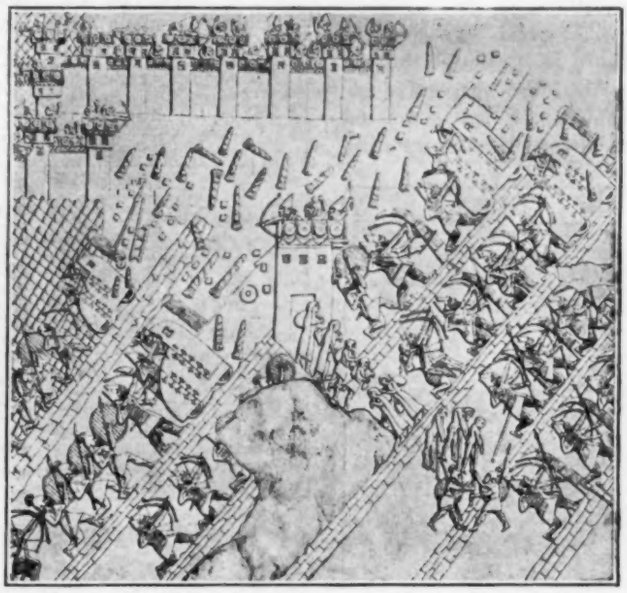


FIG. 1. BESIEGED HURLING FIREBRANDS (ABOUT 800 B. C.)

In Roman times the soldiers of Lucullus, while besieging some of the cities in Asia Minor, were attacked by "a liquid fire which burned the warrior in his armor" and could be extinguished only by sand or earth. This was probably a use of bitumen, or naphtha, similar to that pictured on the Assyrian bas-relief. A Chinese war book of the fifth century B.C. describes the employment of fire in battle, and gives the composition of certain mixtures that burned fiercely and were difficult to extinguish. A picture by a Chinese artist, Fig. 2, dated perhaps 1000 A.D., shows that such inflammable materials were frequently made up in tubes of bamboo which were cast at the foe. Tubes of this sort were at times thrown by engines of war having bows or springboards after the fashion of the artillery employed by Roman armies in ancient times. The greatest development of liquid fire took place in the Middle Ages. The Emperor Constantine VII in his directions for the administration of the empire, written for his son, has the following account of its introduction: "Know that during the reign of Constantine Pogonatus (668-685 A.D.) one Kallinikos who fled from Heliopolis to the Romans (at Constantinople) made a wet fire to be discharged from siphons" [probably a form of syringe—Editor] "by means of which the Romans burned the fleet of the Saracens at Kuzikos and gained the victory." This battle took place during

the first siege of Constantinople by the Moslems. The records state that the Saracens came down upon the city in 1800 ships, most of which must have been small. Constantine removed the chain guarding the narrows, and when the ships were crowded into a small space he sent boats carrying Greek fire against them. The boats caused so great a conflagration and such tremendous destruction that the fleet was no longer mentioned in connection with the siege, and at the end of the war only five galleys returned to Alexandria.

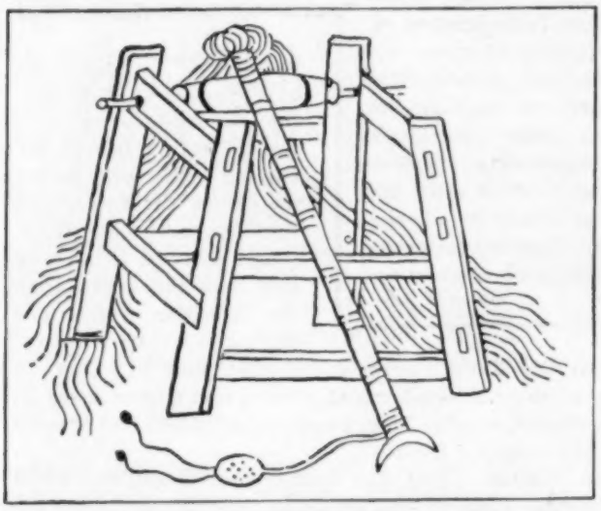


FIG. 2. BAMBOO FILLED WITH CHINESE INFLAMMABLE MATERIAL (ABOUT 1000)

Greek fire was also used with great effectiveness against the land forces, and there is no doubt that to this agency alone must be ascribed the successful resistance of the city. Just what Greek fire consisted of, or how it was handled, has always been something of a mystery, but it decided so many battles, and indeed wars, during the Middle Ages as to deserve further examination.

FIG. 3. DISCHARGING GREEK FIRE FROM A POLE

Anna Comnena, the daughter of the eastern emperor Alexis, reveals to some extent the method of using it. In her narrative of the battle between the Greeks and the Pisans near Rhodes in 1103 A.D. she says: "In the bow of each ship he put the heads of lions and other land animals made of brass and iron and painted so as to be frightful to look at, and he contrived that from their mouths which were open should pour the fire which should be delivered by the soldiers through the flexible apparatus."

FIG. 4. CHARIOT AND GREEK FIRE

The Princess Anna does not state what this "flexible apparatus" was, but the term would fit in very well with the siphon mentioned by the Emperor Constantine if it were a hose for the wet fire, for it will be remembered that the Romans had long used a siphon, and even a double siphon, or forcing pump, as a fire engine to throw a stream of water. On the other hand, as will be seen later, some kind of spring may have been used to discharge the siphon, and this may be the "flexible apparatus" mentioned by the princess.

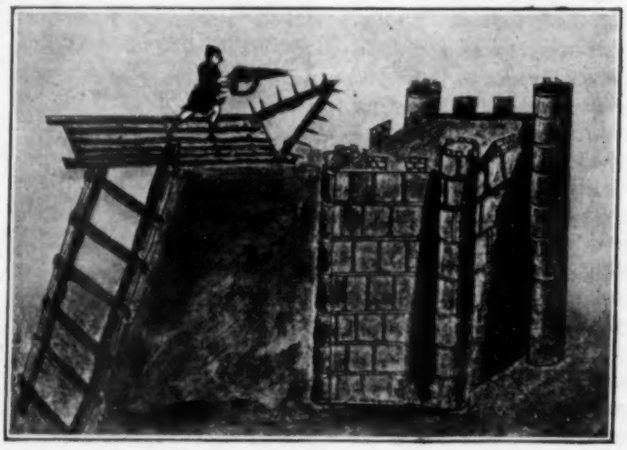


FIG. 5. DISCHARGING GREEK FIRE FROM A SIPHON (11TH CENTURY)

On land the operation of handling this Greek fire was always somewhat different and at times entirely so. Anna Comnena states that in using Greek fire on land the soldiers were supplied with copper tubes and blew the fire through them upon their enemies. The Greeks also threw fire in barrels, poured it from large kettles or shot arrows and javelins bound with flax and tow which were soaked in it, but the mixture may not have been the same in all cases as that used in naval battles.

Several medieval pictures extant show the use of fire by soldiers on land. In one case, Fig. 3, the fire is depicted issuing from the end of a long pole which is

held by a knight clad in armor and on horseback. Another cut, Fig. 4, portrays the flame being discharged from a long pole in front of horses drawing a chariot. Here the horses are protected by a mantle which was suspended from the tongue.

The ingredients of genuine Greek fire are not definitely known. They were kept the closest secret at Constantinople, and as Gibbon says: "The galleys and artillery might occasionally be lent to the allies . . . but the composition of Greek fire was concealed with the most jealous scruple, and the terror of the enemies was increased and prolonged by their ignorance and surprise." Constantine VII directed his son to say that it had been revealed to Constantine the Great by an angel and must therefore be kept sacred.

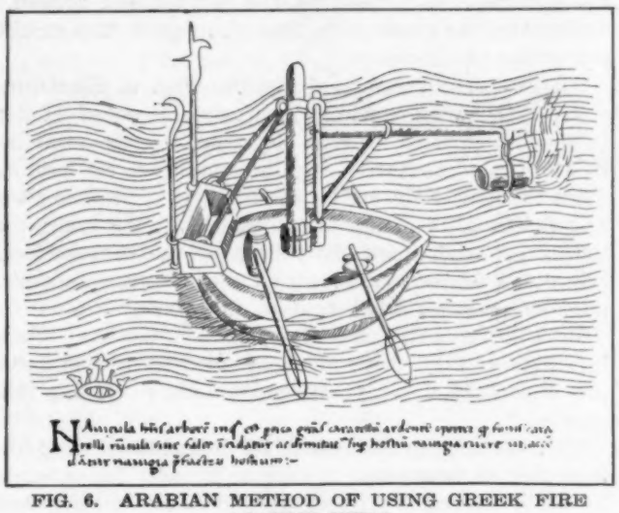


FIG. 6. ARABIAN METHOD OF USING GREEK FIRE AGAINST SHIPS

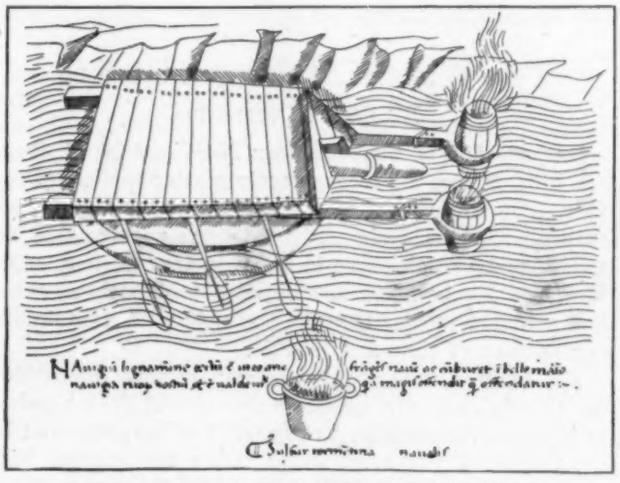


FIG. 7. ARMORED RAFT CARRYING FIRE

The two most suggestive characteristics of Greek fire were that it could be projected from a siphon or tube and that it could not be put out by water, but could be extinguished by earth or vinegar. It has been suggested that its basis was naphtha and sulphur, but that when used on the sea quicklime was added to it, the contact of which with water produced sufficient heat to ignite the other materials.

An interesting eleventh-century picture, Fig. 5, shows the use of Greek fire against a fortress. In this case some sort of siphon is undoubtedly portrayed, and in the picture it looks as if a spring were employed to discharge the syringe, but the details are not clear enough to make this certain.

The secrecy surrounding Greek fire was maintained for several centuries, but during the Crusades we find the Saracens using either this fire or an imitation of it against the Crusaders. In Geoffrey de Vinsauf's "Itinerary of Richard I of England" there are several passages concerning it. In his description of the naval battle near Acre, 1190 A.D., he wrote: "The Saracens fire the decks with burning oil, which is vulgarly called Greek fire. That kind of fire with a detestable stench and livid flames consumes both flint and steel. It cannot be extinguished by water, but is subdued by a sprinkling of sand and put out by pouring vinegar on it."

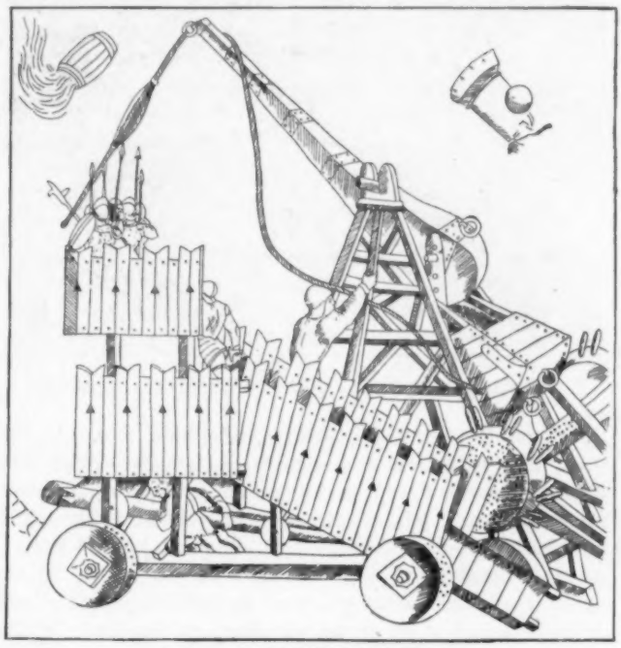


FIG. 8. FIRE-HURLING SLING

FIG. 9. FIERY DRAGON OF KONRAD KEYSER (1405)

It is doubtful whether the Arabians had discovered the genuine Greek fire which in naval battles was discharged through siphons. Several Arabian pictures of the early Middle Ages illustrate the use of fire and

FIG. 10. MEDIEVAL FIRE-BREATHING IMAGES

inflammable materials, but not of liquid fire. In one boat, Fig. 6, which is depicted the fire is carried in a barrel at the end of a swinging spar. In another boat, or rather raft, Fig. 7, the two barrels of inflammable materials are at the end of fixed beams. This raft is interesting in that the rowers seem to be below the surface of the water and that it has an armored top.

De Vinsauf goes on to say that at the siege of the city the same year "the enemy set fire to our towers, which our utmost endeavors could not extinguish, and being burnt with Greek fire they were rendered useless."

The tremendous psychological effect of such fire, as well as some of the methods of using it, is brought out in de Joinville's memoirs of Saint Louis IX in his

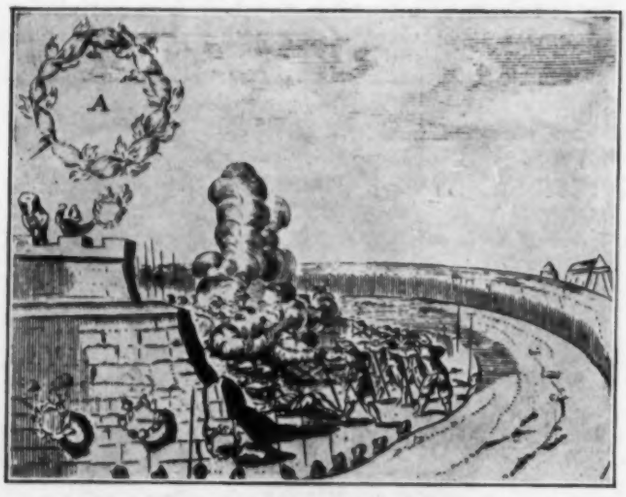


FIG. 11. HURLING FIERY WREATHS (1647)

crusade, 1249 A.D. Near Damietta in Egypt the Turks brought up against the camp an engine called *la perriere*, "from which the Turks flung such great quantities of Greek fire that it was the most horrible sight ever witnessed. . . . Sir Walter cried out, 'Whenever they throw any of this Greek fire, cast yourself on your knees and cry to our Lord for mercy.' This Greek fire in appearance was like a large hogshead and its tail was like a long spear; the noise which it made was like thunder, and it seemed a great dragon of fire flying through the air, giving so great a light with its flames that we saw our camp as clearly as in broad day. Thrice this night did they throw the fire from *la perriere*, and four times from crossbows. Each time that our good king Saint Louis heard them discharge the fire he cast himself on the ground and prayed." Twice the Saracens with this fire burnt the castles protecting the camp.

An interesting medieval picture, Fig. 8, illustrates a great throwing machine hurling a hogshead of fire in much the same way as described by de Joinville. In this case the throw was accomplished by hauling down the long, light end of the beam to which the sling was fastened, inserting the hogshead in the sling and letting go, whereupon the falling of the tremendously heavy end of the beam whirled the sling up and over and cast the hogshead against the enemy.

In a later battle, according to de Joinville, "their infantry ran toward our men and burnt them with Greek fire which they cast from instruments made for that purpose."

The use of fire continued for some time after the discovery of gunpowder. Konrad Kyeser, for example, in 1405 illustrated a man on horseback, above whom floats a fiery dragon similar to those used by the Chinese in comparatively recent times, Fig. 9. A rather quaint medieval cut depicts a cavalryman who has in front of him a hollow statue from the mouth of which issues the fire, Fig. 10. In the foreground four other men are pushing a cart upon which is the figure of a fire-breathing steed. As late as 1647 Nathaniel Nye, in his work "The Art of Gunnery," included an engraving, Fig. 11, which illustrated the throwing of wreaths of fire against the besiegers.

Two Ways of Molding a Casting

BY SANDY COPELAND

On page 551 of the *American Machinist* M. E. Duggan tells us how the inconsiderate molder spoiled all his (Mr. Duggan's) careful pattern work by nailing together with horrid old rusty nails the pattern that he had taken so much pains to make in two sections, with the parts nicely fitted and doweled together to enable that selfsame molder to make the mold with a minimum expenditure of time and trouble.

Mr. Duggan then goes on to explain that the molder did this to avoid the necessity for special flask rigging in the cope, presumably to support the hanging sand in the center of the mold which, after the parting was made at the top of the pattern, was supported by gaggers.

I would like to ask Mr. Duggan how much farther down this sand would have hung, how much heavier it would be, and why it could not have been supported by the same gaggers if the mold had been parted at the center, assuming that a cope flask of sufficient depth had been used?

It would seem to me, on looking in at the foundry window, that making 16 cores with a hacksaw and file almost constitutes "special flask rigging," and if that molder did it "in less time than would have been required to take the pattern to the pattern shop" then the pattern shop was a darned long way off.

Bursting Grinding Wheels

BY CHESLA C. SHERLOCK

The fact that every shop where grinding wheels are in use is liable to have wheel breakage makes the legal questions involved of general interest. This article cites numerous examples of cases and the decisions of the courts under various circumstances.

GRINDING wheels are common appliances in every machine shop, and judging from the numerous cases that have come to the attention of the courts concerning them they are a fruitful source of injury to employees. There is always more or less danger to a workman when he is engaged in his duties near rapidly revolving machinery, and this danger is even greater when he is working with that kind of machinery.

The common faults in the case of grinding wheels seem to be their operation at an excessive rate of speed with insufficient flanges and the use of different types of wheels that are unsuited for the kind of work to be performed.

Expert testimony in many of the cases shows that to operate a grinding wheel at excessive speed is to incur the danger of the wheel bursting, no matter what precautions may be taken. Excessive speed may be defined as any rate of speed that renders the operation of a wheel unsafe. For instance one wheel may be operated at a speed of 3000 r.p.m. and be unsafe, while another may be operated at even greater speed and be perfectly safe.

In questions of this nature the courts must rely largely upon expert testimony to determine the relative capacity of wheels. While this is ordinarily a good way for the courts to get at justice in a technical matter, in many instances they are imposed upon by "experts." Too often an expert is apt to air his own pet theories regarding certain technical questions that are asked, with the result of possible injustice being done to one or both of the litigants.

CRITICISMS OF COURTS

Much of the criticism that is generally placed on the courts for their decisions in industrial matters should not properly be meted out to them, but should be placed on the expert testimony that so largely influences them. While many of the cases concerning grinding wheels are apparently grounded on justice, there are many persons engaged in industrial pursuits who disagree with the courts. Therefore every technical expert should exercise absolute impartiality and justice when called before the courts to give his opinion on matters related to his profession.

In a federal case the question of insufficient flanges came up. It was alleged that the workman was injured by a bursting emery wheel, and that the wheel was run without flanges attached to the sides thereof, which made its running dangerous, improper, unsafe and liable to burst. Evidence also showed that the plaintiff did not know of the danger incident to so running the wheel. It was also disclosed that there were flanges on the wheel, but that they were too small and rendered the operation of the wheel unsafe. According to the nature of the testimony given by the experts there was a case against the employer, but the court threw the case out on a legal technicality and ordered a new trial, which no doubt resulted in a verdict in favor of the injured workman.

In a Missouri case the plaintiff was injured during the second day of his employment. He had been set to work with an 18-in. emery wheel by the foreman who had shown him how to operate it. The plaintiff was inexperienced in the use of these wheels, and at the time of his injury was only 19 years of age. The injury was caused by the wheel bursting, pieces of it striking him in the head, breaking his skull and causing serious injuries.

DIFFERENCE IN WHEELS

The wheel was a straight-sided wheel as distinguished from a convex-sided one. The negligence alleged by the plaintiff was that he was furnished with a straight wheel instead of a convex wheel, which is thicker at the center than at the periphery and with slanting clamps adjusted to prevent broken pieces from flying in case of breakage, and in failing to instruct plaintiff, who was ignorant thereof, as to the dangers incident to the operation of the wheel. Two experts were called and they testified that any kind of emery wheel is apt to break; that straight emery wheels were in general use and that they could not recall having seen any convex wheels in any of the large manufacturing plants in the immediate vicinity, though they had seen some exposed for exhibition or for sale. It was shown from the evidence of these experts and other witnesses that at very rare intervals during a period of 25 years straight emery wheels had been known to burst.

The lower court gave a verdict of $5000 in favor of the plaintiff. The supreme court, however, held that it was error to submit the question of negligence to the jury in furnishing a straight emery wheel instead of a convex wheel, and that as the defendant was not negligent in furnishing a straight wheel, and that there was no testimony that such wheels were so inherently liable to break as to require defendant to take notice that they were dangerous, the defendant could not be said to have had notice that such wheels were inherently dangerous to his employees and that he was not negligent in failing to warn plaintiff of the dangers incident to its use. The judgment in favor of the plaintiff was accordingly revoked.

In Massachusetts the plaintiff and a fellow workman were engaged in grinding a heavy casting on an emery wheel when the wheel broke a few seconds after the plaintiff noticed that it had commenced to wobble. The wobbling of the wheel was due to the overheating of the babbitt metal at its bearings, a condition which had not changed substantially from the time of the accident to the time of the examination of the witness who testified to that fact, which hardly could have happened

in the few seconds of operation of the machine immediately before the accident, and which might have been discovered by efficient inspection. The court affirmed a judgment of $10,000 in favor of the plaintiff, holding among other things that whether plaintiff appreciated the situation and comprehended the danger in the few seconds during which the wheel wobbled before breaking was a question of fact for the jury, and that therefore it could not be said as a matter of law that the workman assumed the risk of continuing to work after noticing the condition of the wheel.

In a Pennsylvania case it was shown that the workman was experienced in the use of emery wheels, having had more than twenty years' experience with them. He had gone to the company's stock of wheels and selected the one which later caused the injury. This wheel he placed on his machine. The arbor, or spindle, was too light for the wheel, which caused the wheel to vibrate and made the grinding of the tools more difficult, but did not render it unsafe. The plaintiff informed the defendant of this fact, but did not claim that the wheel was dangerous and did not believe it was dangerous. It was held that no recovery could be had because if the plaintiff, a skilled workman, did not consider the wheel dangerous then his employer had no reason to believe that it was.

In a New York case the plaintiff was set to work by his foreman polishing iron castings. The foreman had taken down the wheel, which consisted of a wooden core surrounded by a leather strip on which glue and emery dust were placed from time to time, and placed it on the machine and directed the plaintiff, a green hand, in the method of using it, and then went away and left him. Almost immediately thereafter the leather strip surrounding the wheel broke loose, owing to a defect in construction, and hit plaintiff in the head and various other parts of the body, inflicting the injuries for which the damages were sought. The evidence showed that there was a "belly" on the wheel and that the plaintiff called the foreman's attention to it and was assured that it was all right. The court held that there was testimony which justified the jury in inferring that this was the only available wheel of the proper size for use on this machine. Judgment for the plaintiff in the amount of $1500 was affirmed.

A Massachusetts Case

A Massachusetts case decided in 1906 clearly illustrated the old common-law rules involving assumption of risk. The plaintiff was working in the defendant's factory where an emery wheel was in operation a few feet behind him. It is not clear whether it was in use at the time of the accident or merely revolving with the other machinery.

The evidence showed that the wheel was new, having just been taken from stock and placed on the machine; that it was revolving at a speed of 3000 r.p.m., and that while the plaintiff was doing other work it broke, a piece striking him on the head. It was also shown that there was no guard on the wheel and that had it been guarded the piece could not have struck the plaintiff as it did. There was no evidence that if the wheel was defective such defect could have been discovered by the exercise of ordinary care or even the highest degree of diligence by the master. The court held that no negligence on the part of the defendant had been shown, and that as the wheel was not guarded when the plaintiff was first employed by the defendant the latter was not obliged to guard it thereafter. Judgment on a directed verdict for the defendant was affirmed.

In a Pennsylvania case the question of what constituted a proper guard for an emery wheel came up. The plaintiff sought damages, alleging that the guard was improper. It was shown that there was a guard on the wheel, but the plaintiff failed to show that the guard was improper. He offered testimony to the effect that it was not the same kind of guard as was used in other manufacturing establishments, but the court held such testimony to be inadmissible. The court held that the plaintiff should have produced a witness who "was familiar with the trade and customs in regard to such machinery to testify that this guard was not a proper guard."

A Wisconsin Case

In a Wisconsin case the plaintiff was a minor 19 years of age, who was injured by the breaking of a carborundum wheel on which he was grinding small castings in the defendant's machine shop. His evidence tended to show that the face of the wheel was $\frac{1}{4}$ in. from the rest on which he held the casting; that this was too much space and rendered the machine unsafe; that in withdrawing the casting from the rest after finishing-grinding it, it was carried down and became wedged between the rest and the revolving wheel, causing the wheel to break, and that he was not instructed or warned as to the danger. The testimony given by the defendant tended to show that the space between the face of the wheel and the rest was only $\frac{1}{32}$ in. and that the casting could not have become so wedged under such conditions or even if the space had been a quarter of an inch. The court evidently was not moved by this plea, as the fact plainly remained that the tool became wedged between the rest and the face of the revolving wheel. Accordingly judgment was rendered in favor of the plaintiff.

In a Minnesota case the plaintiff was at work about forty feet from where another workman was working with a 24-in. emery wheel that revolved at the rate of about 1000 r.p.m. At the time the operator had temporarily removed the guard the wheel burst, a piece of it striking the plaintiff and inflicting a compound fracture of the thigh bone. The statute of Minnesota contains the following provision in regard to emery wheels: "No grindstone, emery wheel or machine in any factory, mill or workshop shall be used when the same is known to be cracked or otherwise defective." In another place in the same statute it is required that all machinery "as far as practicable shall be fenced or otherwise protected." The court held that the statute required employers to guard their grinding wheels; that this duty was a continuing one, and that therefore the defense that the act was that of a fellow servant was not applicable; that the defenses of assumption of risk and contributory negligence were not available as it was not shown that plaintiff knew that the guard had been removed, and that the guarding of the emery wheel was required for the protection of workmen in the factory whether engaged in operating such wheels

or in other duties. Judgment in favor of the plaintiff in the amount of $4000 was affirmed.

In a Michigan case the factory of the defendant had been visited some 19 months prior to the accident by a deputy factory inspector who had given the defendant written notice to guard their grinding wheels. It was evident from the nature of the case that the employer has disregarded this notice, although it had been made under express provision of the Michigan statute. The court held that the question of whether the notice was properly given was properly a question for the jury and that such an order, if given, would cover all installations in the future.

Where the question brought to the attention of the courts is simply one of guarding the wheels they are of easy solution. It is where the questions involve inherently technical matters calling for the opinions of others, especially of experts, that there is more or less uncertainty and obscurity in some of the decisions that have been rendered.

Introducing Woman Labor Into the Shop

By M. C. HOBART
Employment Manager Albaugh-Dover Co., Chicago

In using women in the shop, much depends upon a proper beginning. The proposition of introducing female labor into the shops has been faced in the past few months by the company alluded to in this article, and its experience should be of interest to other employers of less than a thousand men who find that they must place women at work if they are to keep their working force up to normal numbers.

NORMALLY the Albaugh-Dover Co. of Chicago, which is engaged in the manufacture of cream separators and cut gears, employs 500 men, but in the past year it has fallen somewhat below this number for reasons too well known to need elaboration. It has met this shortage by placing women in the shop both on bench and machine work.

The first step after the company had decided to employ women was to plan a rest room for them, which was pleasantly located in the building and finished in white, with proper toilet facilities; the furnishings for the room were selected by the woman supervisor. As soon as the rest room was under way we set out to find a supervisor to take charge of the women. The one selected was a graduate nurse who had had much experience in dealing with women in factory work. She came to the company before any of the women were hired and in time to take charge of the final furnishing of the rest room. A space 60 ft. by 22 ft. was provided, which it is anticipated will be ample unless over 100 women are employed, in which case it will be necessary to enlarge it. One end of this room is used for individual steel lockers while the remainder is provided with chairs, tables, a lounge, a water cooler, a gas stove, etc. In the selection of the furnishings the supervisor demonstrated her ability by the way she disposed of this matter the first day. Too much emphasis cannot be placed on the necessity of having a competent woman in this position from the start. The supervisor is an assistant of the employment department, and as the name implies she has to deal with the relations of the women in the shop to their foremen and to the company.

Several hundred applications from women who desired to do shop work were obtained by advertising, and the most promiseful were called. At the outset the supervisor and the employment manager interviewed the women applicants, but as it took the supervisor only a short time to become familiar with the shop and the work that the women were to do this detail is now left entirely to her. As with the men the foreman of the department for which the applicant is hired has the right finally to accept or reject the applicant for work in his department.

The first women that were hired were started on bench work in the inspection department; then others were put at soldering, assembling and similar work within a day or two. More were added during the first few days than was thought possible, and the gear-cutting department soon received a number for operating both hobbing and shaping machines. From these machine operations it was only a short step to lathe and screw-machine work, and now, in six weeks' time, there is not a department that does not have women on at least part of the operations. It was found advisable not to start less than two women in a department, and it was carefully explained that as it took the men weeks to become competent at the work the company did not expect the women to learn everything in a day. With the department foremen, the general foreman and the supervisor watching over the newly hired workers and their instruction little difficulty has been experienced in overcoming any discouragement shown by the women during the first days of their employment.

Effect of Advertising

After a short period of advertising and as soon as the employees of the company learned that women were being hired, many of the workmen brought in their relations or friends for positions, so there was no dearth of applicants. Apparently, however, there are not a great many women with machine experience in the city who are looking for work. This was anticipated and preparations made to accept inexperienced help and break them in as was done in many cases with the men. The same wages are paid to the women as are paid to the men for the same work, and this fact is advertised and stuck to religiously. In many cases the women pick up the work more rapidly than the men. As a great number of inexperienced women have never been added at any one time arrangements were easily made for their instruction in the department where they are to work. The foreman of the department is responsible for this instruction and where he is not able to give it

personally he assigns one or more of his best men to assist the women and explain the operation of the machines. At a later period it is intended to pick one or more of the women who are proficient at the work to instruct the beginners.

When an inexperienced woman does not like the work she is given or is not fitted for it the supervisor arranges for her transfer to another department that is satisfactory, and in most cases this has been easily accomplished. In this particular alone it is important to have a competent woman with authority to look after such transfers.

In order to eliminate any feeling among the women, and partly for safety, all the women are compelled to wear the regulation shop uniform, which consists of a pair of overalls with a high bib, a black shirt (men's style) and a cap. Only two of all the women refused to wear the uniform, and they were not permitted to go to work.

I visited another manufacturing plant recently which employs women on work similar to ours and found that many of the women in the shop were wearing lace waists, boudoir caps, etc., and that this company was about to adopt a shop uniform, but it will save much trouble if such a rule in respect to a uniform is made at the outset. The company furnishes the uniform to the women, but holds her responsible for it, and it must be returned in good condition when the woman leaves its employ. The uniforms are washed by the women, passes being given to them in order to take them out for the purpose.

The company has never provided seats for the men and it started with the same idea with respect to the women. It was found, however, that on some of the automatic machines there were short intervals during which the women could rest, and stools were provided for them in these departments. In the lathe department no stools are provided and the women taken for this work are chosen for physical strength as well as their skill. Each woman is allowed a 10-min. rest period in the morning and in the afternoon, during which she may be absent from her work, and the foremen are responsible for seeing that this privilege is not abused.

Time for Women

A separate time clock for the women has been installed at the entrance to their rest room and they start 15 min. later in the morning than the men, but they have the same lunch hour and leave at the same time. They work 48¼ hours, but if they have a perfect attendance they are paid for the regular week of 49½ hours. If they lose time due to absence or tardiness they are paid for the actual time that they worked during that week.

Employment men agree that married women with families are rarely satisfactory workers, as they remain away from work when anything goes wrong at home. To meet the problem of the more frequent absence of women workers an emergency squad of women is being organized by selecting half a dozen of the best workers and training them in the various work that women are doing in the shop and holding them to take the places of those who are absent or who leave without notice. The positions on this emergency squad will pay better than the others and it is thought that they will be eagerly sought. At the same time because of the existence of this emergency force no department will be held back in its work because of the absence of any workers.

Except in rare instances girls under 20 years of age are not hired, and as a result there has been little trouble in discipline. The company had anticipated objection by the male employees on the introduction of the women, but nothing developed. One or two men left because of it and a few showed reluctance to give any assistance to the women in showing them, but these cases were of minor importance.

The foreman in each department is responsible for the discipline therein while the supervisor cares for the rest room and general conditions. In addition to hiring older women a certain undesirable class that often creeps into factory work has been debarred. There is no reason why the factory atmosphere in regard to women should be particularly different from that of an office, and it is mainly what the supervisor and the executives make it. The coöperation of the foremen is essential in the matter of discipline, instruction and other points. A few days before the women were put to work the company held its regular monthly executives' meeting at which the women's supervisor was present. The subject of women in the shop was discussed in all its phases and the interest and coöperation of all the foremen assured.

It has been said that women are more liable to accidents than men, but this company has not as yet observed any particular difference in the accident rate. The insurance company that handles our workmen's compensation was notified of the action of the company in employing women and said that it had not as yet adopted any official action to meet such conditions, although it might have to do so in the future.

For those who are contemplating the employment of women in the shop I would warn that to do this is not just as simple as hiring a certain number of women and have them come in to work the next day. It has cost us from forty to fifty dollars apiece to place the women now in our shop, the subjoined being a summary of the main expenses in connection with the innovation: Rest room with furniture, lockers, etc.; uniforms for women; separate time recorder for women; special tools necessary because no woman has her own; shop tools needed for women; advertising for and weeding out applicants; a competent supervisor.

The general belief in our organization is that the money and time have been well spent and it is hoped to double the present number of women within a few months.

Conservation of Automobile and Gasoline Engine Mechanics

A request that all automobile, motorcycle and motorboat racing and speed contests be suspended for the period of the war is made by the United States Fuel Administrator Garfield.

The request comes as a result of the growing need for the conservation of gasoline and because of the demand for skilled automobile drivers and mechanics for war service. A strict compliance with the request is earnestly desired.

War Sparks from Industry's Forge

Edited by E.C.Porter

Hog Island has effected another novelty in shipbuilding. A few days ago three women electrical welders were placed at work in the correction of plate work in the plate and angle shop. They received their instruction under the supervision of the training school.

* * *

In order to demonstrate the carrying capacity of one of the new Allied bombing planes a full-sized upright piano was carried from London to Paris and safely landed across the English Channel. This new bombing plane is capable of carrying six persons and much bombing explosives.

* * *

Those who do not have an opportunity to fly, but wish to become familiar with airplane construction and equipment, now have an opportunity to do so by taking a correspondence course in airplane mechanics offered by the extension division of the Kansas State Agricultural College. The course consists of 18 lessons and treats of the theory, materials, engines and construction of airplanes. Anyone interested in mechanics can pursue the work without difficulty.

* * *

The War Department authorizes publication of the following circular from the office of the Adjutant General: The University of Colorado located at Boulder, 30 miles northwest of Denver, will admit to all departments free of tuition or other charges all honorably discharged soldiers and sailors from any state who possess the required educational qualifications. The School of Law of the University of Colorado will admit all honorably discharged soldiers and sailors who have had a high-school education or its equivalent, though two years of college work is required of other applicants for admission.

* * *

Authorization has been given to acquire either by purchase or condemnation 3300 acres immediately adjoining Camp Humphreys at a price which it is estimated by the facilities section of the General Staff will reach $280,000. The tract is owned by about 100 persons and on it are 80 houses. Only a small section of the land is to be used for camp purposes, the remainder being provided for the maneuvers and instruction work of the engineer regiments which are in training at Camp Humphreys. The railroad leading to the present camp runs through the tract. The land is well adapted for engineering work, there being gulleys and high points at several places. It is traversed by a creek, which furnishes the water supply of the camp.

* * *

Caleb Bragg, civilian pilot attached to the Engineering Department of the Bureau of Aircraft Production, flew from McCook Field, Dayton, Ohio, to Bolling Fields, Washington, D. C., in a De Haviland "9" plane equipped with a Liberty engine in 3 hours and 5 min. with no stops. The distance between these cities is 430 miles and the rate of flight was 143 miles an hour. The pilot traveled by compass at a high altitude and reported no difficulty in holding his course. An engineering officer accompanied the pilot as a passenger. In regard to the De Haviland plane and Liberty engine it was shown by figures presented to the House Military Committee at a conference recently that up to Oct. 4 the total production of De Haviland planes was 1694 and of the Liberty engine 8216.

* * *

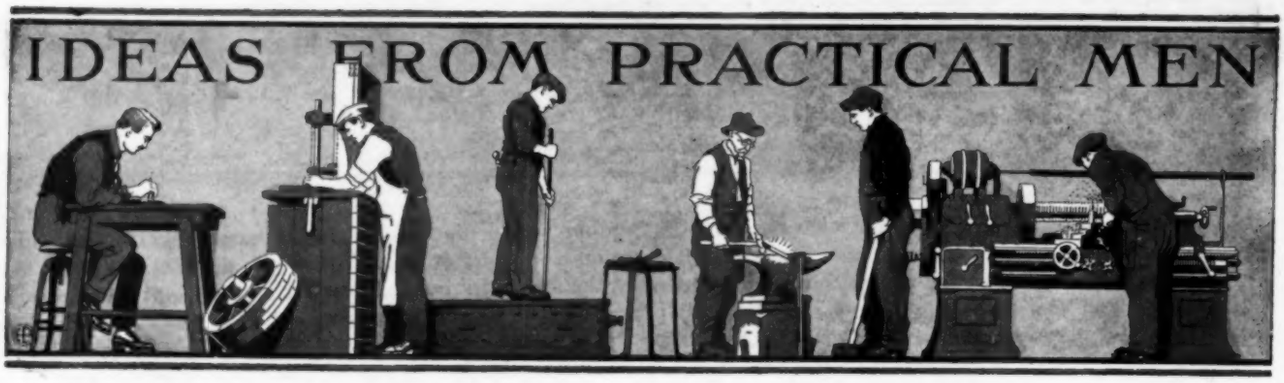
According to regulations recently announced by the War Labor Policies Board children under 14 years of age cannot be employed on war work. Children between 14 and 16 years of age cannot be employed more than 8 hours a day nor before 6 a.m. or after 7 p.m. and no more than 6 days a week on war work. The board further states that the prohibition of employment of children below certain ages does not imply that their employment above these ages is favored. It merely states these regulations because of the great demand that children be included in the industrial mobilization for war. It points out that children of 14 or 16 years of age recruiting for war work are certain to lose their value as trained workers in later life.

* * *

The Emergency Fleet Hotel for employees at Hog Island, said to be one of the largest of its kind in the world, is now in operation. It has accommodations for 2175 men and is divided into four units, each consisting of four buildings containing 540 bedrooms, a dining-room, kitchen, two recreation rooms and shower baths. Every room has steam heat and screened windows with an outside exposure, assuring plenty of light, air and sunshine. They are 9 x 10 ft. in size. The recreation rooms are furnished with heavy mission rockers, writing tables, standing electric lamps and reading tables. Popular, scientific and mechanical magazines and stationery will be supplied to the patrons without cost. The rate is $10 a week for a room and two meals a day.

* *

The manufacture of ball bearings and steel balls has been recognized as an essential industry by the War Industries Board. Any member of the industry whose plant is now or in the future shall be exclusively devoted to manufacturing products being or to be absorbed directly or entirely by the Government or in other uses of essential importance may have his plant given a class B-3 rating for steel and iron. This rating is given on the condition that the usual pledge of coöperation be signed and that the rules of the Priorities Division be followed. Manufacturers whose entire output does not go for Government use may file application for places on the preference list and will be rated according to the extent of their direct or indirect Government business.

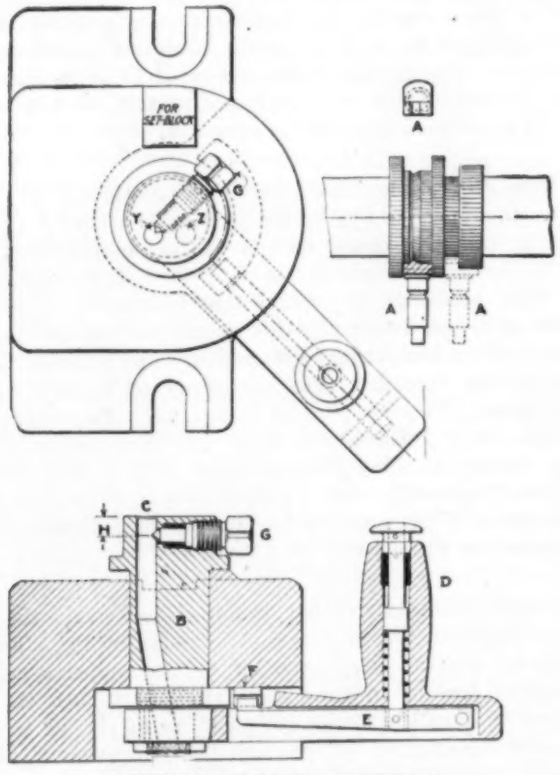


A Two-Position Milling Fixture

By P. P. Fenaux

The fixture here described is to mill the head of the part shown at *A* in the illustration. It is a screw-machine part made from round stock, three sides of the head being milled as well as the top. We used to mill it in three operation in as many different fixtures, but with the advent of a Pratt & Whitney automatic-milling machine in the shop we looked for some means of reducing the number of handlings.

The fixture consists of a hardened tool-steel holder *B* with a locating hole *C* eccentric in relation to the



A SPECIAL MILLING FIXTURE

center. A handle *D* is keyed to *B* and can be located in two positions at 90 deg. through latch *E* and locating ring *F*.

In operation the work is clamped in place by screw *G* while the handle is in the forward position. At first a quick-acting clamp was provided, but it was found that no time was gained and that the clamping mechanism was in the way. Screw *G* is made with a coarse thread so that a one-half turn does the clamping or releasing. Dimension *H* is made slightly longer than the corresponding dimension on the work to make sure that the latter will be properly seated.

The machine is then started, and while the table is coming back after the cut the operator moves the handle to the rear position and is able to start the table going again as soon as the end of the stroke is reached.

By moving the handle in this manner the work is moved from position *Y* to *Z*, that is 90 deg., the distance between the centers of the two positions being utilized to locate the milling cutters in the gang.

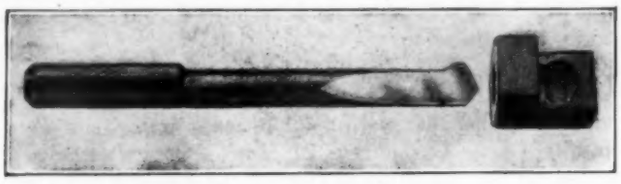
With a 3-in. feed per minute an average production of 30 pieces an hour with one operator was obtained. With two automatics the operator could tend both.

Undercutting Tool for Tap Holes

By M. L. Lowrey

The tool for undercutting tap holes, described by Mr. Chapman on page 804, Vol. 48, is interesting to an old-timer like myself, as it shows to what length one can go to secure a result that may be accomplished equally well with a very simple tool.

The tool with which we do these jobs in the wild and woolly West may be seen in the cut, which shows



A SIMPLE UNDERCUTTING TOOL AND ITS WORK

not only the drill but a piece of material that has been cut away to show the shape of the hole. I have used drills of this type since 1879 and do not know how much older the idea is.

[Many years ago, when we were very young and knew vastly more about the machine business than we do now, we saw an old "jour" preparing to use this tool, who upon being asked what it was for explained what he intended to do with it. With profound contempt for the journeyman's ignorance of mechanical principles we quietly told our fellow apprentice that "Jim thinks he's going to bore a hole big at the bottom with that fool drill. You just hold your breath till he does it." A few minutes later friend apprentice came along to our bench and said: "Say, Jim's done it; kin I breathe now?—Editor.]

Conservation of Tin in Bronze Bearing Metals

By G. H. CLAMER
First Vice President and Secretary Ajax Metal Co.

Most of our executives in the machinery-building lines are accustomed to demanding a high-percentage constituent of tin in important and unimportant bearing metals. How this unnecessary use of tin involves a waste of this valuable element in many cases is explained by a manufacturer who has had wide experience with these bearing metals.

UNFORTUNATELY no serious attention prior to the war was given to the subject of conserving tin, notwithstanding this country is practically entirely dependent upon outside sources for its supply. This was merely one of the many neglected matters which went to make up our program of unpreparedness.

Tin is of vital importance in many industries, but it is surprising how many excellent substitutes there are when acquaintance with them is had. Tin has always been a relatively high-priced metal, and it is part of the human attitude to associate high prices with high standards. Tin has always been preëminently the autocrat of the common nonferrous metals. It is not until the price of a commodity becomes wellnigh prohibitive that we hunt for substitutes, because we are so imbued with the idea that that which we have is good if we pay a high price for it, and the idea of a substitute always carries with it the belief that the substitute must necessarily be inferior.

The history of the development of bronzes now used for bearings is a striking example of this policy. In the early days copper and tin alloys were almost universally used for bearings. The idea was then prevalent and is still held by many that a bearing to resist wear must be hard; consequently, in accordance with this idea, the harder the bearing the better. The favorite bronze bearing in use was the alloy 90 per cent. copper 10 per cent tin, and frequently in service that was considered severe even higher tin-content alloys were used.

Such hard alloys have great resistance to compression, and although they ably support the loads they are designed to carry, they have as a rule a very wide factor of safety in this respect. Such bearings, because of their inability to adjust their bearing surface to slight irregularities in the journal, or of foreign bodies which may become lodged between the bearing surfaces, immediately begin to cut, and heating therefrom results. With a slight rise in temperature the film of lubricant becomes thinner and further cutting results, if not actual gripping of the bearing with the journal.

Many years ago Dick, of England, appreciating the advantage to be derived if a bearing be more plastic or yielding in its nature, added some lead to the then standard bearing metal of 90 parts copper and 10 parts tin. He, however, did not substitute lead for tin, but reduced his copper content, producing at that time the alloy which has long held favor as a bearing metal, namely, copper 80 per cent., tin 10 per cent., lead 10 per cent. The alloy produced by Dick also contained some phosphorus, but the main point which I wish to bring out at this time is that this was the first step in the direction of the production of bronze alloys having a plastic nature.

Lead is the metal having the highest degree of plasticity. Furthermore it does not unite to form an alloy with copper, but remains mechanically mixed in the alloy, so that the structure of the same becomes a hard matrix with the soft metal inbedded therein.

It was not until several years after the introduction of this alloy by Dick that tests were conducted on the Pennsylvania Railroad under the direction of Dr. C. B. Dudley, deceased, and then chemist of the railroad. Dr. Dudley studied the copper-tin-lead series of alloys within certain limits of the 80-10-10 alloy, and he not only investigated the alloys with lead above 10 per cent., in which copper was replaced by the lead, but he also studied those alloys in which tin was replaced by lead, and as a conclusion drawn from the study of the actual service performance of many hundreds of bearings he formulated what is now a fixed law governing them, as follows: (1) The rate of wear diminishes with the increase of lead in the alloy; (2) the rate of wear diminishes with the diminution of tin in the alloy. Fortunately it so happens that the alloy with least tin and highest lead content exhibits less tendency in the service to give trouble due to heating.

Merits of Copper and Tin

Notwithstanding the decided merit of bearings of copper and tin containing lead as compared with those not containing this element, there was in the early days of the introduction of such alloys a decided prejudice against them merely because lead has always been a low-priced metal. It was even intimated that such alloys were frauds, should be considered such and dealt with accordingly.

I have often drawn attention to the above law regarding bearing metals as discovered by Dr. Dudley, and have emphasized the fact that it was due to his findings that we instigated research work 20 years ago which has led to the production of alloys still higher in lead and lower in tin than those which Dr. Dudley was able to produce, because he met with foundry difficulties which apparently limited his maximum alloy to 77 per cent. copper, 8 per cent. tin and 15 per cent. lead. This was the alloy known as experiment B alloy, and has since been widely known as extra B metal.

We found that by having due regard to the raw materials used we were able by merely following good foundry practice to produce alloys carrying 5 per cent. of tin and as much as 30 per cent. of lead which would show no segregation of lead even if cast into large bearings. What I mean by segregation of lead is that such bearings will show no indication of metallic lead upon any surfaces. Lead being only

*Extract from a paper read at the meeting of the Institute of Metals Division, American Institute of Mining Engineers, Milwaukee, Oct. 9, 1918.

mechanically held in the alloy it is prevented from segregating only by the quick setting of the matrix of copper and tin. The uniformity of the bearing, therefore, depends largely upon the quick setting of the matrix.

As a certain lapse of time must necessarily take place between the time when the metal enters the mold and the time when it solidifies there is always some indication in the bearings of the tendency of the lead, owing to its high specific gravity, to liquate toward the bottom of the casting. In bearings made of the proper raw materials and properly handled there is, however, a difference of not over a fraction of a per cent., or at most 2 to 3 per cent. of lead between samples taken from the top and bottom of the casting, even if such casting be fairly large and be made of the 30 per cent. alloy.

I do not wish to here repeat data that I have given in previous papers—for example, Franklin Institute, March, 1903; American Society for Testing Materials, June, 1907; American Institute of Metals, September, 1915—but I do wish to clearly set forth the position and standing which the high-lead and low-tin alloys developed by us have attained. When these alloys were first produced they were backed only by laboratory tests and the predictions of Dr. Dudley that if such alloys could be commercially produced the law which he established and which has been above referred to would no doubt also hold good for alloys higher in lead and lower in tin than those which he had developed. It is now possible for me to review 18 years' experience with the manufacture and service of such bearings.

Compressive Strength

I must confess that in our enthusiasm because of the valuable properties of these alloys we were led at times to overstep the mark and place bearings of these alloys in service where the loads or the impacts were too great. The difference in performance of an alloy consisting of 80 per cent. copper, 10 per cent. tin and 10 per cent. lead and one containing 65 per cent. copper, 5 per cent. tin and 30 per cent. lead is merely one of degree. In accordance with Dr. Dudley's laws the rate of wear and the tendency toward heating in service is diminished by the diminution of tin and the increase of lead in the alloy. As the percentage of tin is decreased and the percentage of lead increased, the alloy becomes softer, or more plastic, and consequently offers less resistance under pressure. In other words the compressive strength is diminished.

The first requisite of a bearing is that it be sufficiently hard to support the load which it is called upon to carry or to resist the impacts to which it may be subjected. The extent, therefore, of the diminution of tin and the increase in lead must be controlled by this requirement. Mistakes have been made by us in the past in recommending the alloy copper 65 per cent., tin 5 per cent. and lead 30 per cent. for certain mill bearings, etc. This alloy did not have sufficient resistance to compression to meet the service requirement, and failed for that reason. When the alloy copper 73 per cent., tin 7 per cent. and lead 20 per cent. was substituted they exhibited no deformation and performed far better than the 80-10-10 alloy previously used.

Then again we have noted the failure of the alloy 73 per cent. copper, 7 per cent. tin and 20 per cent. lead on rod bearings of very heavy locomotive equipment for the same reason. Locomotive-rod bearings are subjected to severe impact strains, and it is necessary therefore to use an alloy of fairly high compressive strength. Although the above alloy performs satisfactorily in the service of light-locomotive equipment it is necessary to use on the rod bearings of heavy equipment either the alloy 80 per cent. copper, 10 per cent. tin, 10 per cent. lead or this same alloy to which has been added approximately 1 per cent. of phosphorus.

The size of such bearings, hence the bearing surface, must be greatly restricted owing to mechanical necessities, otherwise these harder alloys would not be essential. Phosphorus increases greatly the compressive strength of such an alloy, and is for this reason advantageous and presents a possibility for conserving tin. At the present prices of tin and phosphorus there is really very little choice, and an alloy with 8 per cent. of tin and 1 per cent. of phosphorus will have compressive strength approximately equivalent to the alloy with 10 per cent. tin.

Percentage of Tin and Lead

Experience, therefore, has demonstrated that the alloys containing tin as low as 5 per cent. and even 4 per cent., and lead as high as 30 per cent., can be used in the service where a vast tonnage is required. Such alloys have become the standard of the United States Railroad Administration for car-journal bearings called for under their specifications R-71, grade A. Such an alloy is also included in the specifications covering locomotive bearings designated as specification R-72, soft bronze.

In my judgment the alloy specified by the Railroad Administration is very satisfactory, except that the use of the soft bronze should also be extended to cover driving brasses and engine and trailer truck bearings. A large conservation of tin would thereby result and the service conditions more satisfactorily met, to say nothing of the large economy thereby effected.

Now allow me to direct your attention to the possibilities in the direction of either substituting some other metal for tin or a part of the tin in the copper, tin and lead alloy or the substitution of alloys of an entirely different type.

The first metal which presents itself as a substitute for tin is antimony. Antimony combines readily with copper and with lead, and has the property of adding hardness. Unfortunately, however, the hardening effect obtained by the use of antimony is with the sacrifice of ductility. Alloys hardened with antimony are brittle. We have found it possible to make alloys carrying as high as 30 per cent. of lead with 3 per cent. of tin and 2 per cent. of antimony. We have also made alloys of 65 per cent. copper, 30 per cent. lead, 2 per cent. tin and 3 per cent. antimony; also have replaced the 5 per cent. of tin in this same alloy entirely with antimony.

Car bearings 4¼ x 8 in. in size made from the same pattern on molding machines and subjected to a breaking strain applied longitudinally at the middle of the back of the bearing and throughout its entire length

broke at the following average figures: With 2 per cent. antimony substitution, 60,000 lb.; with 3 per cent. substitution, 62,000 lb.; with total substitution, 52,000 lb.; compared with the breaking strain of 67,000 lb. for the alloy copper 65, tin 5, lead 30.

This shows in a way the relative brittleness of those alloys containing antimony as compared with the alloys without antimony. The castings produced in each of the three alloys aforementioned are not as satisfactory as those made with the straight tin alloys, the castings being more or less rough and showing slight globules of lead on the surface. It has been found that a certain amount of nickel can be used in replacing the tin with very satisfactory results. The castings produced, however, by the substitution of a certain amount of the tin by zinc are decidedly unsatisfactory. The substitution of tin by aluminum is entirely impractical and such castings are worthless.

Referring to the possibility of substituting alloys of an entirely different type this presents an attractive field for research. The copper-tin-lead alloy has attained its position in the industry as the most desirable bronze-bearing alloy. This does not necessarily mean that some other alloy may not be found which might give equally good or better results. In making investigations in the search for such a substitute alloy it should be borne in mind that the alloy should possess the following properties:

1. It should be sufficiently rigid to support the load or resist the impact, but yet not brittle so that it will easily crack.
2. It should have a maximum yielding or plastic nature consistent with its ability to support the load or resist the impact without deformation of the bearing as a whole.
3. The ideal structure is a hard matrix to support the load and a softer metal or alloy contained within such matrix which will give the bearing surface the ability to adjust itself to the irregularities of service.
4. It should be capable of ease in handling in the foundry and in the machine shop.
5. It should be capable of being remelted without deterioration.
6. For use in babbitt-lined bearings it should be capable of being tinned so that the babbitt can be applied thereto.
7. It should have good heat conductivity in order to dissipate the heat generated by friction.

New York Meeting of the National Screw Thread Commission

The National Screw Thread Commission conducted a public hearing in New York on Oct. 7, at which manufacturers and users of certain classes of threaded products were invited to give testimony in regard to the present practice in screw-thread manufacture and to suggest the lines along which standardization should proceed.

The following topics or questions were given consideration:

1. As a national standard, is there any objection to the continuation of the U. S. Standard system of thread diameters and pitches for general use in practically its present shape?
2. As a national standard, is there any objection to the adoption of the S. A. E. system of diameters and pitches of fine threads.
3. As a national standard, to what extent could the A. S. M. E. system of standard machine screws be adopted?
4. There seems to be a general feeling that in standardization we should make it possible to cover several classes of work, and there has been suggested a minimum of four classes of fits to provide for different grades of work ranging from reasonably wrench-tight fits to very loose fits. Would such a classification, including at least four classes, be sufficient for all grades of work encountered in the various systems of threads previously mentioned, or would a classification including more than four classes be required?
5. Is there any objection to adopting the "Standard hole" practice for screw threads; that is, the practice of making all the taps for any particular thread of one basic size and securing the required fit by changing the diameter of the screw or male threaded work which is to assemble with the nut cut by the basic tap?

The consensus of opinion of those present was as follows:

(1) The U. S. system should be continued practically in its present form for the ordinary threaded work, to which it is well adapted.

Objections were raised to its use for diameters less than one-half inch on the ground that for small work the U. S. pitches are too coarse and the threaded work too much weakened by excessive depth of thread.

(2) The S. A. E. system is satisfactory for use where finer threads are necessary, as, for example, in automobile and airplane work.

(3) The A. S. M. E. system should be used to supplement the U. S. system for diameters less than one-quarter inch, and all sizes from 14 to 30 should be discontinued in order that there may be no overlapping of the two systems. A minority thought that all A. S. M. E. sizes should be retained.

(4) Classification of Fits:

The general opinion was that four classes of fits would be ample to provide for all ordinary threaded work, and that very probably three classes would be sufficient, since it was felt that wrench fits, stud fits, etc., which could not be covered by general specifications, should be classed as "special" and no attempt made to include them in the regular classification.

(5) Standard Hole Practice:

There was a sharp difference of opinion on the question of whether the nut or the screw should be made basic, with the majority favoring the former.

A part of the objection to making the hole basic arose from a misapprehension. It was suggested that if the tap or the tapped hole were made basic it would be necessary to carry in stock several sizes of bolts in order to provide for different classes of fits. Such, however, is not the case, since in general only a single class of fit will apply to each threaded product and only that class would be carried in stock. For example, machine screws should be made within certain tolerances, while bolts for agricultural machinery would require larger tolerances and there would be no necessity for providing for machine screw fits on agricultural machinery bolts, or for "agricultural fits" on machine screws.

EDITORIALS

100-Percenters, Step Forward!

AS ANNOUNCED on page 591 of our issue of Sept. 26 we are anxious to print an honor roll of American machine shops that have made a record of 100 per cent. on the Fourth Liberty Loan.

A number of 100-percenters have sent in their names already. We received the first notification on Oct. 5 in the following words:

> You will perhaps be interested if we tell you that yesterday afternoon the Cincinnati Bickford Tool Co. shop went over the top. We are a 100-per-cent. shop, every employee in the place having subscribed.

Let us hear promptly from you, other 100-percenters. Our illustrating department is now at work on an honor roll that you will want to hang on the wall, especially if the name of your shop is "among those present."

An Attempt to Standardize Machine Tools

STANDARDIZATION is one of the most attractive and at the same time most dangerous germs that can attack an engineer, even when he is thoroughly familiar with the different phases of the particular field in which he is engaged. But when this germ finds a resting place in the minds of those who are not competent to deal with the subject great care must be taken to prevent disastrous results.

* * *

Every machine-tool designer and production engineer at some time has dreamed of standard machine tools and other shop equipment. Careful investigation, however, has convinced him that any widespread attempt at standardization is not only impractical but also undesirable in many ways. This can be proved by making a list of the main parts of a lathe, planing or milling machine, and carefully considering the advantages and disadvantages of standardizing the various parts. It will be found that, aside from the tool-holding and work-holding fixtures, very little is to be gained by such standardization. It is of course assumed that the speeds and feeds are so proportioned as to give the desired production on the particular kind of work for which the machine is to be used.

The machine-tool industry of this country has been developed by long years of hard work to its present ranking position among the essential industries. In Great Britain and in this country it is now recognized as the industry that is the key to all other industries, and it is because of its great importance that extreme care must be taken to prevent any interference that might decrease its ability to do its full share in winning the war.

There is at present a committee for the purpose of standardizing machine tools. With the best of intentions, but without in the least realizing what the task really involves, it is proposing to accomplish complete standardization in five weeks' time. This alone shows how unfamiliar with the situation the committee is, as were such a standardization necessary or desirable it would mean years of hard work by the most competent engineers and machine-tool designers of the country.

* * *

This is, however, not the time to argue the pros and cons of the propriety of such standardization, but only to consider, and to consider carefully, its effect on the production of machine tools, which also means the production of every implement of modern warfare. It requires but a few moments' consideration to show the serious effect any attempt at machine-tool standardization would have at this time, and if we wish concrete examples of the delay caused by an exaggerated desire for standardization we have only to study the motor-truck and the airplane situations.

It must be obvious to even those who are not familiar with the circumstances in the machine-tool industry that every manufacturer can produce more machines of the type that he is accustomed to build than if he is compelled to embark in making entirely different products. Suppose, for example, the small-arms division of ordnance had insisted on the standardization of rifles to the extent of preventing the manufacture of everything but the Springfield 1903 model. Such a decision would have compelled the largest manufacturers of rifles to abandon all the tools, fixtures and gages with which they were equipped, and to spend months in making new tools, fixtures and gages for the Springfield rifle. It would have delayed the production of rifles many months and would have been an inexcusable blunder.

* * *

Any decision to attempt the standardization of machine tools during the war would be even more disastrous and should not be considered for a moment, no matter how much those on this committee may believe in the desirability of such standardization. Without arguing for or against such standardization in times of peace it is impossible to urge too strongly against such a move during the war.

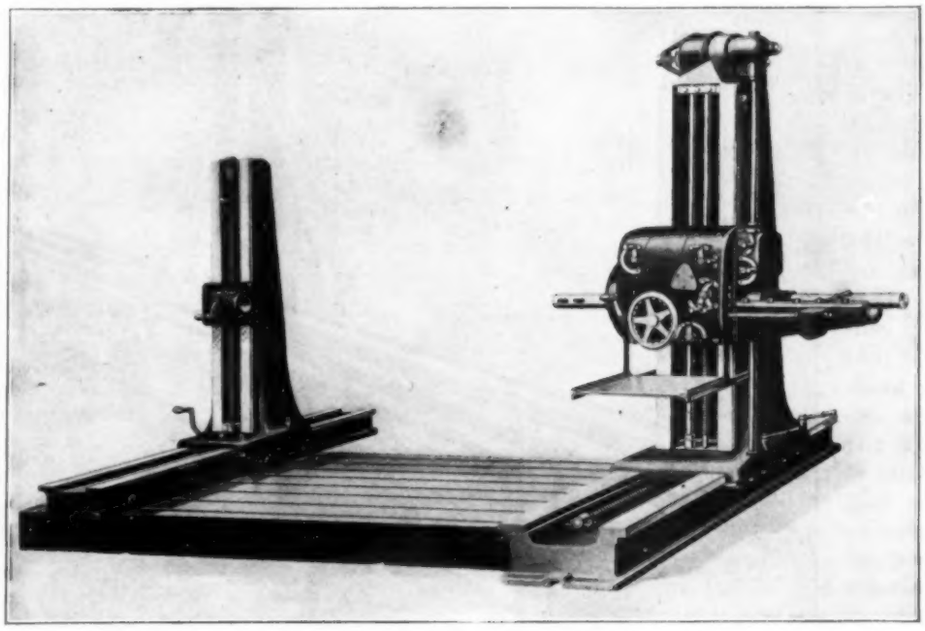
"Guilty!"

THE poem "Guilty!" sent out in poster form with this issue, is to drive home the responsibility of the worker and his relation to the fighter at the front. No worker can lay off from his job and the consequences not be felt in decreased output. A worker who deliberately lays off without good and sufficient reason is not merely a slacker—he is a *deserter* without leave from the industrial army that is backing the fighting army.

This department is open to all new equipment of interest to shop owners. Photographs and data should be addressed to Editorial Department, "American Machinist"

Gidding & Lewis No. 4 Boring, Milling and Drilling Machine

The Giddings & Lewis Manufacturing Co., Fond du Lac, Wis., is now placing on the market the No. 4 horizontal boring, drilling and milling machine shown in the illustration. The machine has a 5-in. spindle and is said to be entirely new. The general arrangement is that used in standard practice, consisting of a balanced headstock, adjusted vertically by sliding on the column ways, and horizontally by sliding the column on the bed, or runaway, which is fastened to the large floor plate having T-slots for use in securing either attachments or the work. At the outer end of the floor plate is a support for the outer end of the boring bar, this being adjustable both vertically and horizontally in order to line up with the headstock. The end support may be moved to and from the column in order to provide a support for the boring bar as near the work as possible. It is said the machine is adaptable, simple, rugged and convenient of operation. All of the drive mechanism is supported in the headstock, and levers are within reach of the operator, who rides on a platform which travels with the headstock. The floor plate is bolted and doweled to the runway, and both are cross-ribbed in order to insure their staying in alignment when provided with a proper foundation. The floor plate is machined all over in order to facilitate the gaging and aligning of work, the T-slots being milled from the solid. The column is also ribbed to insure the necessary strength, and the base or bottom surface spreads out and slides on the ways on the bed, long taper and square-locked gibs being used to eliminate any lost motion between these parts. The end support is slid over the top of the floor plate, being guided by a long key. It is entirely independent of the rest of the machine and can be easily removed to accommodate extra large work. All adjustments on this unit are made by hand. The headstock is of box section and slides on the column on two taper square-locked gibs. The face, or outside, surface is supplied with a cover which may be removed to gain access to the spindle sleeve bearing or other inside adjustments. Oil reservoirs are located on top within reach of the operator, these supplying the lubrication for all bearings. The operator's platform is suspended from the bottom of this unit and rides with it. When the headstock is at its lowest posi-



GIDDINGS & LEWIS NO. 4 FLOOR-TYPE HORIZONTAL BORING MACHINE

Diameter of spindle, 5 in.; length of spindle, 108 in.; continuous feed of spindle, 48 in.; size of hole in spindle, No. 6 Morse; maximum distance from spindle center to floor plate, 92 in.; minimum distance from spindle center to floor plate, 20 in.; size of floor plate, 8 x 12 ft.; maximum distance from faceplate to outer support, 124 in.; size of spindle sleeve front bearing at large end of taper, 9¾ in.; size of spindle sleeve back bearing, 7 in.; speeds, twelve, 4 to 160 r.p.m.; feeds without changing gears, sixteen, 0.0037 to 1.08 per spindle revolution; feeds on change gears supplied, forty-eight, 0.0007 to 5.4 in. per spindle revolution; vertical travel of head on column, 72 in.; horizontal travel of column on runway, 96 in.; surface of column bearing on runway, 40 x 64 in.; rapid traverse in all directions, 4 ft. per minute; motor recommended, 15 hp., 1200 r.p.m.; diameter of face gear, 24 in.; pitch of face gear, 3; height including motor, 13 ft. 4 in.; floor space, 16 ft. by 24 ft. 6 in.; size of keyways in spindle, ⅜ in.; weight, 38,000 lb.

tion, however, the platform supports telescope and allow it to ride on the ways of the bed.

Heat-treated, hammer, high-carbon steel is used for the spindle, which is positioned close to the face of the column to eliminate overhang. It is ground to size and the front end is bored to receive the Morse taper shank, tang and drift key, while the back end is equipped with a ball thrust bearing through which the feed is transmitted by the use of a ram carrying the rack, which disengages from the pinion at both extremes of motion. This is, of course, for safety purposes and prevents any damage to the machine due to carelessness of the operator.

Power is transmitted to the spindle from the sleeve by means of two splined keys located diametrically opposite, and at each end of the sleeve is a take-up collet. The sleeve is of the same material as the spindle and is supported in two adjustable bronze bearings. The front face of the sleeve is adapted to receive milling cutters and facing attachments. Two driving gears are secured to the spindle sleeve; the front or face gear, being the larger, receives its power through the sliding back gear shaft. The power is transmitted through a variable-speed unit containing heat-treated steel clash gears cut with stub teeth. The high-speed shafts in this unit are ball seated, while the heavy-duty shafts run on phosphor-bronze bearings.

Power for operating the feed unit is carried from the speed unit through a set of change gears supported on a quadrant accessible from the operator's position. Extremes of maximum and minimum feed may be obtained by these change gears, but they are only supplied as extra equipment, as the feeds provided cover the general run of feed required. The feed gearing itself is carried in the headstock at the lower right corner, the gears being cut with stub teeth and heat-treated. With the exception of the spindle, which obtains its feed through self-locking worm gearing and the ram, all feeds are produced by means of phosphor-bronze nuts equipped with ball thrust bearings which revolve on stationary coarse-pitch lead screws. They are anchored at each end to eliminate possibility of buckling. The rapid traverse is independent of the feed and takes its power directly from the initial drive. It is supplied with a constant feed, which is at all times in the opposite direction to the feed being used, and is controlled by levers which make it impossible to engage the rapid traverse and feed simultaneously. The rapid traverse can be engaged in either direction by placing the feed-reverse lever in neutral. A safety friction is placed in the feed unit, the adjustment for this friction being from the outside. A shearing pin is also used, and this is located for convenient replacement. Safety trips are provided at the extremes of all feeds, and all gears and revolving parts are guarded.

The centralized control is composed of clash gear-shifter levers for the feed, speed and back gear units. There are levers for reversing both the feed and speed, and a selector lever is provided for directing feeds to any one of the units required. If two feeds are required simultaneously a fixture designed to supply the second feed by hand can be incorporated. Scales and verniers are provided on the face of the column, bed and runways for positioning. The machine is supplied for either belt or motor drive, the motor recommended being a constant-speed machine placed on top of the column, whence it transmits the power through a set of spur and bevel gears to the vertical driving shaft.

Blevney Type A Tube and Rod Polishing Machine

The Blevney Machine Co., Greenfield, Mass., has recently placed on the market a new machine for polishing tubing, rods or other cylindrical parts whether they be made of metal, rubber, fiber or other such material. Fig. 1 gives a general view of the machine, while Fig. 2

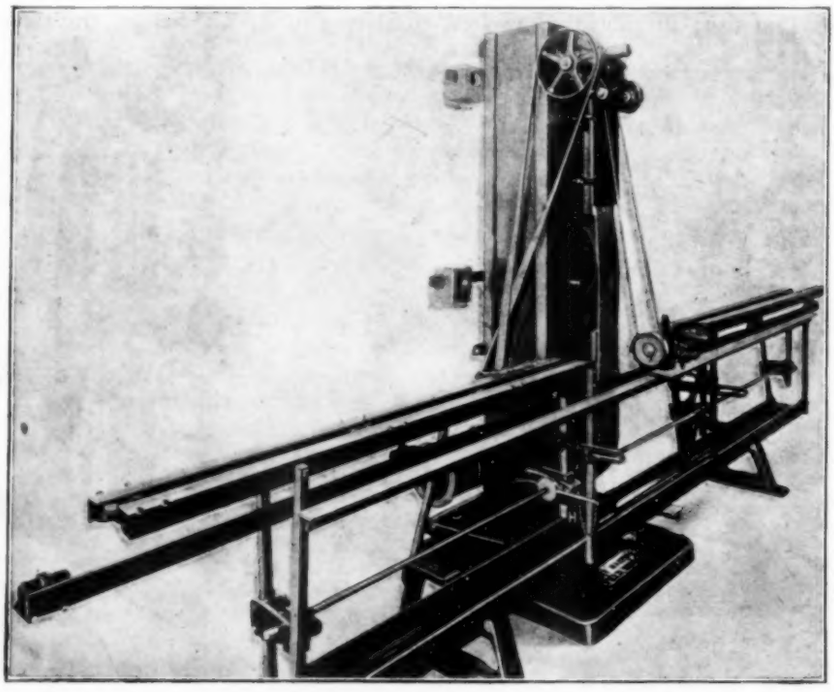


FIG. 1. BLEVNEY POLISHING MACHINE FOR TUBES AND RODS

is a close-up view with a tube in place. The automatic feed is taken care of by means of the feed roll shown in the center, Fig. 2. This has a bearing nearly its entire length and the lubrication is by means of a grease cup. The feed roll is attached to the machine in such a way that it can be arranged to feed in either direction or may be adjusted so that the work is held stationary with regard to motion along its length. The framework for supporting the tube or rod is made up of standard steel shapes and rollers are provided upon which the tube moves. Tubes of different diameters are accommodated by rocking the frame carrying the feed roll to and from the frame carrying the tube proper. This movement is secured through a ratchet-and-pawl

mechanism, the controlling handle of which may be seen at the center of the machine in Fig. 1. At the rear of the tube in Fig. 2 is shown the device that presses the

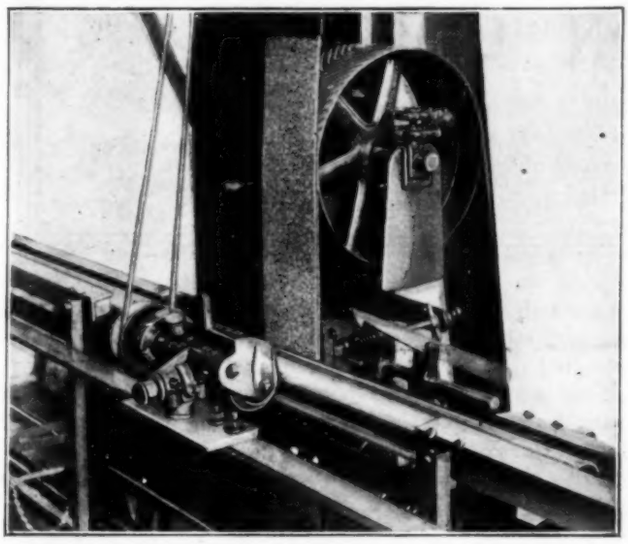
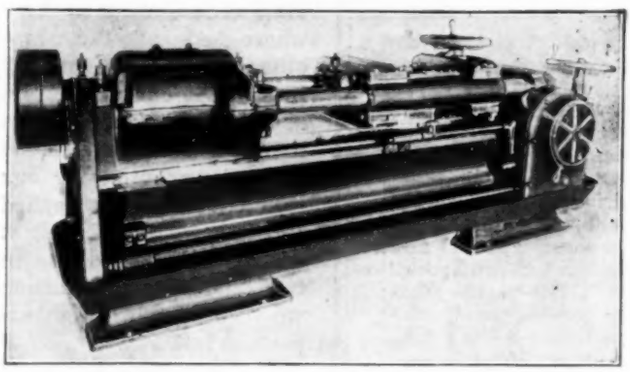


FIG. 2. CLOSE-UP VIEW, SHOWING FEED ROLL

belt against the tube. This may be removed for adjustment or for replacing by one of different form without stopping the machine.

Reed-Prentice Boring Machine for Gasoline-Engine Cylinders

The double-bar boring machine shown in the illustration is the recent product of the Reed-Prentice Co., Worcester, Mass., and has been made for the purpose of boring the cylinders of gasoline engines. The head unit contains a herringbone gear reduction, the bearings being of bronze with sight-feed oilers. The spindle is

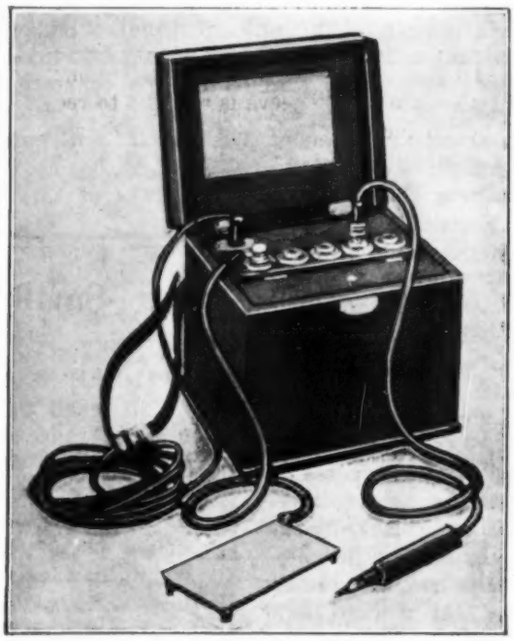


BORING MACHINE FOR GASOLINE-ENGINE CYLINDERS

hardened and ground on all bearing surfaces and the drive is through a single pulley giving but one spindle speed. The feed is positive gear driven through a single train and a worm and wheel with an approximate reduction of 100 to 1, an automatic positive knockout being provided for the power feed. Rapid movement of the carriage is by means of a handwheel. The carriage which carries the cylinder has a clamp which holds this securely in place. The carriage moves on round bars instead of on the customary ways, this construction giving support in the direct line of pressure when the machine is in operation, the bars taking the end pressure when the boring is being done. The machine shown in the illustration has been particularly designed for work on Liberty motor cylinders, but can, of course, with slight changes be used for other similar work.

Electro-Stylograph

The Electro-Stylograph Co., 1 Madison Ave., New York City, is now marketing the Electro-Stylograph shown in the illustration. This device is for the purpose of marking tools, gages and other metal parts by means of electricity. The advantage claimed for it is that any name, lettering or design can be easily etched into the parts in a manner similar to that in which a person would letter or draw with a pencil or



ELECTRO-STYLOGRAPH

pen. The part to be marked is placed on a steel plate connected to the controlling apparatus, and the design is worked on with the pointed hand tool. The device operates from the ordinary lamp socket and is portable.

Simplex Bench Surface Plates

The Simplex Tool Co., Woonsocket, R. I., is placing on the market a new bench plate designed for laying out and inspecting machine parts and tools. The plate

SIMPLEX SURFACE PLATES

is of heavy construction, is ribbed on the under side in order that it will not change its shape, and is furnished in two sizes with either a planed or scraped surface as desired. The sizes are 12 x 14 and 20 x 30 inches.

LATEST ADVICES FROM OUR WASHINGTON EDITOR

Washington, D. C., Oct. 19.—An encouraging sign is the increasing selection of big men to act as advisers or special assistants in the huge manufacturing problems which confront the nation. In addition to the names we have already given in this connection we are pleased to note the selection of W. W. Coleman of the Bucyrus Co., Milwaukee. Wis., and T. H. Symington, whose munition work in Rochester, N. Y., has become so well known. Thoroughly practical men of this kind, whose knowledge of manufacturing is based on facts and not theories, cannot fail to strengthen the staff of the Chief of Ordnance or to be of great assistance to those whose manufacturing experience is more limited.

The loss of life caused by the explosion at the Gillespie loading plant brings forcefully to mind the question of proper recognition for the war workers who risk their lives without the excitement and glamour of the fighting lines or the chance of recognition or reward. According to statistics compiled by the War Department about 85 per cent. of the war work is carried on in this country, and while much of it is no more dangerous than the ordinary pursuits of peace times this cannot be said of such occupations as that of loading shells with TNT and similar high explosives. It should also be remembered that many are working in these plants from a sense of duty as well as for the pecuniary reward.

There is much talk of a standard insignia for war workers, and it is understood that this matter is now in the hands of the highest authorities for final decision. It is an important matter and should receive careful and speedy attention, for war workers should have some badge that at once proclaims their part in the struggle, just as the uniform of the soldier or sailor tells what either is doing. But this is not enough. Some method of recognizing devotion to duty, of indicating that the war worker has been wounded at duty, should be devised and put into immediate use, which should also be retroactive so as to apply to all who have been injured in the past.

In a recent accident, which did not even get into the papers, four girls in a loading plant lost their eyesight and are not only disfigured but handicapped for life. Can there be any question as to their deserving all the recognition we can give them in the way of a "wound stripe," not to mention the same financial remuneration, which we would give a soldier who lost his sight in battle or in the premature discharge of a gun? Is it not common justice to treat our war workers, whose labor is absolutely necessary to winning the war, with the same consideration as those whose duty calls them into other kinds of danger? Should not our war insurance, which is one of the best things we have in the way of providing for our men in uniform, be applied to those whose war duties are extra hazardous, as in the case of the munition workers handling high explosives?

The men who lost their lives at the Gillespie plant belong in the casualty list the same as those who lay down their lives in France. Their families should be made to feel that they belong to the nation's dead as much as though they died in France. Recognition of this kind would go far toward increasing the ardor of the men and women engaged in dangerous war work, and it is but simple justice that they should be so recognized. The movement cannot be started too soon and, as suggested before, it should be made retroactive, for in doing justice to them we are honoring our-

Small Tools Needed for France

THERE is great need of large quantities of small tools and similar material for use in France and at the various depots in this country. Manufacturers and dealers are urged to look over carefully the following list of material and to send complete details of any portion of it that they may be able to supply to Lieut. H. E. Obenshain, Miscellaneous Section, Procurement Division, Sixth and B Sts., Washington, D. C.:

High-speed cutters for grooving taps and reamers, Nos. 2 to 8; gear-cutting machines for pitches 1 to 22; taper mandrels and expansion bushings for same in large quantities; plain mandrels from ¼ in. to 1¾ in.; milling cutters of various sizes and kinds; reamers, roughing, chucking, finishing and rose; dial test indicators; saws for slitting metal; drill sleeves or sockets for Morse taper; boring and turning tools and holders; center drills; lathe dogs; taps and dies; steel letters for stamping; twist drills; drill chucks and extra jaws; drill-press vises; C-clamps, drop-forged; lathe chucks, combination; self-opening die heads, and hollow-milling tools, adjustable.

selves and showing that we do not place military effort above effort to win the war.

The new preferential list, No. 2, issued by the War Industries Board is causing considerable trouble in some quarters because of its incompleteness. In some cases the local, or district, coal administrators are refusing coal to well-known machine-tool builders because their names have been accidentally omitted from the list.

In any such case the machine-tool builder has only to refer the coal administrator to page 7 of the circular where machine-tool builders are clearly recognized as essential whether they are engaged in Government orders or not. As long as they are manufacturing machine tools they are in the preferential class and can demand coal to supply their needs. If there is any trouble in getting it we should be glad to know of such cases and to be of assistance.

Those in charge of this work know that it is impossible for every machine-tool builder to show a Government order for all his work, and also that every machine-tool builder's product goes to some form of essential industry. They have taken the broad view of the matter and have recognized that the building of machine tools is a basic industry, which is in itself a distinct gain for the machine-tool business. Never again will it be necessary for us to plead and argue as to the necessity of machine tools to carry on the country's business, whether that business be peace or war. The machine-tool business is on the map of the nation's vital industries—and on to stay.

The Machine-Tool Industry in Great Britain

To show the extent of government control in Great Britain I am quoting from a letter recently received from a well-known machine-tool builder of that country:

With regard to your inquiry as to the machine-tool business on a war footing on this side I would say that the trade is looked upon here as a key industry, and in fact it is one of the most essential industries in the country at the present time, and the demand, especially for precision machinery, is greater than ever. The general policy is such that anything of this nature that can be produced in this country is purchased here, and this of course is necessary not only from an exchange point of view but for the saving of shipping, which is a considerable item in these days when all the available freight is needed for either food or raw material; consequently the position of the industry is even more essential now than it was in prewar days.

Skilled Salesmen Exempt

As regards military recruiting all skilled machine-tool salesmen having practical experience in machinery are exempted, as the men have been called on more than ever to instruct unskilled labor and to help in the various dilution schemes where women are brought in to a very large extent to forward the production of machine tools in English works. Also several of our men have been lent to the War Department as instructors and placed in various works, and one or two have a roving commission to visit different localities in connection with training schools for semi-skilled labor and women.

To give you some idea of the extent of dilution I may say that in one plant there are about 520 men and 160 women, and in the grinding department women are doing the whole of the grinding in connection with machine-tool production with the supervision of only two men, who act as foremen and supervisors.

We have not found it possible to replace machine-tool salesmen and experienced mechanics with low-grade medical category men, as the demand is much greater than the supply. In consequence of this, all machine-tool experts, mechanics and similar workmen over the age of 23 are exempt from military service. Up to a few months ago, the younger men were exempt, but owing to the insistent demand for more men, apprentices from 18 to 23 are now drafted into the army. Of course the age limit may be raised later when the production of machinery can cope with the supply. At present there does not seem to be much possibility of this occurring.

The machine-tool industry was the first one in Great Britain to be controlled by the War Department. Not only were the lines of manufacture controlled but a curb was placed on superfinish of machines; painting and polishing were eliminated and a war finish prescribed (which consisted mainly of one coat of paint on the casting) with the idea of conserving labor as far as possible.

Prices Strictly Controlled

Prices are strictly controlled and the general rule is that no machine-tool manufacturer can make more than his prewar rate of profit, or the average rate of profit in the two years preceding the outbreak of war. Any advances given to labor, which of course reflects in higher costs of material, are taken into account by an application for an increase in price, and it is only when a firm can prove that it cannot earn their prewar rate of profit that an increase in the price of the commodity is granted. This, of course, was designed to stop profiteering, and on the whole it has worked very well. Naturally there are occasional cases of hardship, but the law has had the effect of preventing manufacturers from obtaining exorbitant prices owing to urgent demands. All forms of control are of course irksome, but in view of the prevailing conditions, there is no question that it has been a very wise move on the part of the government, and has prevented unscrupulous firms from obtaining prices for their goods out of all proportion to the value.

Control of Small Tools

I may say that up to very recently, however, no control has been placed on what is known as "small tools," such as chucks, drills, taps, milling cutters, etc., except where merchants are concerned. In this case their profit is limited to approximately 15 per cent. on these lines, and as a general statement merchants are only allowed 10 per cent. profit except where the articles are under £2 ($10) in value, when 17½ per cent. is allowed. On small tools it is probable, in view of a control committee that is being appointed, that these rates may be revised later.

The tendency of the government is to eliminate merchants entirely, because it is purchasing probably 70 or 80 per cent. of the whole demands, and the remaining proportion is ordered by firms who are, strictly speaking, government firms, being under its control. The government, however, respects any prewar working agreement, as in one case where a firm acts as selling agents for a machine tool company which makes grinding machines on a 10 per cent. commission basis. This percentage may be revised at any time should the government wish to make any alteration.

Of course, in the States the business and selling have always been more or less through dealers, and possibly in view of this you will have no difficulty in getting the American Government to recognize any existing customers for trade.

Standards of Finish

Considerable discussion arises from time to time regarding the best method of indicating the kinds of finish on drawings and blueprints. In some shops any dimension that is not given is to be scaled, although this is not usually considered good practice, especially where drawings are made to a reduced scale on account of the variations produced by washing and drying the blueprint paper. Other shops use common fractions on dimensions where the tolerances are not close, the usual allowance being $\frac{1}{64}$ in. of all dimensions that are not given in decimals.

The practice of the Russell Motor Car Co., Toronto, Canada, and Buffalo, N. Y., is to designate a certain finish by number, so that there can be no question as to the tolerance desired. Its list comprises eight different finishes as shown in the subjoined table:

Finish No. 1	0.0005 in.	Finish No. 3½	0.010 in.
" " 2	0.001 "	" " 4	0.025 in.
" " 2½	0.003 "	" " 5	Forging
" " 3	0.005 "	" " 6	Casting

The Exporting of Machine Tools

As there is considerable equipment being stored in New York and other ports instead of being put in actual service, the following statement by the War Industries Board should be of interest to the machine-tool trade:

In supplying machines for foreign shipments manufacturers should be sure that an export license has been granted by the War Trade Board, and they should get a license number before the machine is shipped or even before it is started in production, especially if it is a special one.

The resolution adopted by the War Industries Board last spring and the recent plan adopted to coördinate the activities of the War Trade Board, which are as follows, cover the matter in detail:

Exports.—In accordance with the action of the board on March 26 Judge Parker submitted the following resolution discouraging the purchase of materials for export, the same to be paid for and put in storage until after the war:

Whereas, It has come to the notice of the War Industries Board that orders have been and are being placed for the production and delivery in the United States of materials, equipment and supplies intended for export, either actually or nominally to neutral countries, but for which no export licenses will be issued during the war; and

Whereas, Many of the products for which such orders are placed are manufactured in accordance with special designs and specifications, rendering it impossible for them to be utilized to advantage or at all in this country; and

Whereas, The said materials, equipment and supplies are being stored for export at the termination of the war; and

Whereas, This practice results in the utilization of materials and labor urgently needed for the production of the war requirements, direct or indirect, of the United States and the Allies; now, therefore, be it

Resolved, By the War Industries Board that the practice here mentioned is to be deprecated and should be discouraged; and be it further

Resolved, That the industries of this country be requested to accept no order for the manufacture of and to make no contract of sale and to make no sale or delivery of any materials, equipment or supplies intended for export until the proposed purchaser has first procured from the War Trade Board an export license or from the War Industries Board a permit to make such purchase.

Exports—Coördinating Activities of the War Trade Board and War Industries Board.—A plan has been adopted to be effective at once, as follows:

1. The proposed exporter will now be required to make but one application, and that in the form of an application for an export license to the War Trade Board.

2. The War Trade Board will in coöperation with the Priorities Committee and other appropriate representatives of the War Industries Board, including the Director of Steel Supply, make proper investigation and give to the application consideration.

3. If the conclusion is reached that an export license should issue it will carry with it such priority rating as may be determined by the Priorities Committee.

4. No order for special manufacture of any article intended for export shall be placed or accepted until an export license covering same has been issued.

Very truly yours,

WAR INDUSTRIES BOARD, MACHINE TOOL SECTION,
G. E. MERRYWEATHER, Chief of Section.

Iowa State Manufacturers' Association

The Iowa State Manufacturers' Association met in Charles City, Iowa, Sept. 26. Over sixty of the metal- and wood-working industries of the state sent one or more representatives to the convention. The call was issued by George Wrightman, secretary of the association, for the purpose of looking over the local industries and to obtain an idea of how these industries might best work together with the large industries here in regard to war contracts.

Personals

F. W. Shumard, equipment and production engineer at the Utica, N. Y., plant of the Savage Arms Corporation, has taken a similar position in Washington, D. C., in the maintenance division of the Motor Transport Corps.

Obituary

William Allis, age 69, son of the late E. P. Allis, died Oct. 10. He succeeded his father as president of the E. P. Allis Co., and so continued until its consolidation with the Chalmers Co., after which he became chairman of the board of directors.

Alfred R. Jones president of the Killes & Jones Co., maker of machine tools for making plates, bars and structural shapes, Wilmington, Del., died Oct. 9, after being afflicted with Spanish influenza. He was 55 years of age. His connection with this company began in 1887 as bookkeeper, then as treasurer. Upon the retirement in 1902 of his uncle, Henry C. Jones, one of the founders of the business, he became president, which office he filled to the time of his death.

Lieut. Philip J. Davidson, treasurer of the Union Drawn Steel Co., Beaver Falls, Penn., was killed in action in France, Aug. 5, 1918. Lieutenant Davidson was born May 26, 1891, and at the time of his death he was treasurer of the concern mentioned and a director in the Union Drawn Steel Co., Ltd., Hamilton, Canada; Davidson Ore Mining Co., Buffalo, N. Y.; Union Coal and Clay Co., New Galilee, Penn.; Knott & Harker Co., Beaver Falls, Penn.; Farmer's National Bank, Beaver Falls, Penn., and Beaver Trust Co., Beaver, Penn. He was also a partner in the firm of the Frank M. Hoover Co., Pittsburgh, Penn. Lieutenant Davidson was a member of the Duquesne Club and the Pittsburgh Athletic Association, Pittsburgh, Penn.; the Fort McIntosh Club, Beaver, Penn., and the Beaver Valley Country Club, Beaver Falls, Penn.

John Washington Wadsworth was born July 6, 1863, in Allegheny, Penn., and died in Leetsdale, Penn. He was one of the oldest employees of Tate, Jones & Co., where he held the position of shop superintendent for 18 years. He was educated in the public schools of Allegheny, and finished his education at the old Western University of Pennsylvania. He had an inventive mind and had several patents to his credit, the last of which was granted in 1911 for a heavier-than-air airship. He was also an acknowledged authority on internal-combustion engines. Mr. Wadsworth is survived by his wife and four sons, one of whom is in France with the Expeditionary Forces. He was a member of the Knights of the Golden Eagle.

Forthcoming Meetings

The American Society of Mechanical Engineers will hold its annual meeting in New York, Dec. 3-6. The secretary is Colvin W. Rice, 29 West 39th St., New York.

American Society of Mechanical Engineers. Monthly meeting second Tuesday. Calvin W. Rice, secretary, 29 West 39th Colvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month. Young's Hotel. Donald H. C. Tullock, Jr., secretary. Room 41, 166 Devonshire St., Boston, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

The National Machine Tool Builders' Association will hold its fall convention at the Hotel Astor, New York, Nov. 7-8.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway Cambridgeport, Mass.

Philadelphia Foundrymen's Association. Meeting first Wednesday of each month. Manufacturers' Club, Philadephia, Penn. Howard Evans, secretary, Pier 45 North Philadelphia, Penn.

Providence Engineering Society. Monthly meeting fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796. Providence, R. I.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

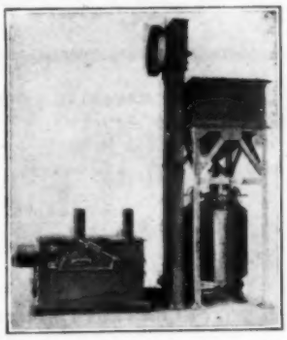
Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 240 Broadway, New York City.

Western Society of Engineers, Chicago, Ill. Regular meetings, first, second, third and fourth Mondays of each month, except July and August. Edgar S. Nethercut, secretary, 1735 Monadnock Block, Chicago, Ill.

Condensed-Clipping Index of Equipment

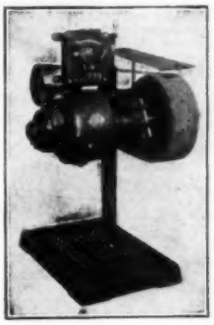
Clip, paste on 3 x 5-in. cards and file as desired

Sandblast for Cleaning 155-Mm. Shells, Type EO
Pangborn Corporation, Hagerstown, Md.
"American Machinist," Oct. 3, 1918



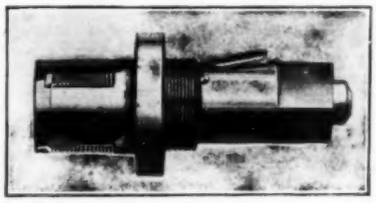
Consists of a cabinet in which are four rotating chucks revolving at slow speed on dustproof ball bearings, the drive being by means of a belt from the main-drive pulley at the rear of the cabinet, the alternate chucks revolving in opposite directions. A direct high-pressure sandblast machine with two lines of hose feeds two nozzles that are positioned to project within the shell openings of alternate shells, two alternate shells being cleaned while the two other chucks are being unloaded and loaded. The nozzles are shifted from one set of shells to the other by means of a lever at the front of the cabinet.

Abrasive Finishing Machine, Motor-Driven, Type B-6
Blevney Machine Co., Greenfield, Mass.
"American Machinist," Oct. 3, 1918



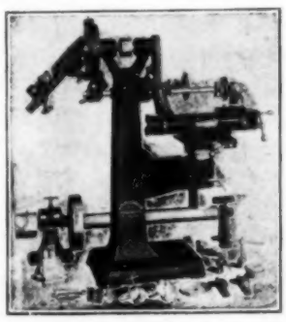
This machine is provided with an individual motor drive, the motor being attached to a yoke forming part of the machine. The connection between the motor and the sectional finishing wheel over which the abrasive belt operates is made by means of a coupling. The cushion wheel is made up of a number of leather sections, it being claimed that this construction gives best results.

Taps, Hand Sizing
Victor Tool Co., Waynesboro, Penn.
"American Machinist," Oct. 3, 1918



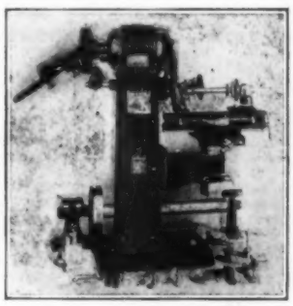
Intended especially for munition work and are similar to standard collapsible taps except that instead of the collapsing feature being automatic the chasers are collapsed by pressing a trigger when the desired depth has been reached. This releases a latch, permitting a tension spring in the body of the tap to withdraw the plunger, so that the chasers which slide along a taper point on this plunger are positively collapsed. The taps are made in any size from 1⅛ in. in diameter up, and may be furnished with a pilot.

Grinding Machine, Cutter, Reamer and Drill, No. O, Belt-Driven
Wilmarth & Morman Co., Grand Rapids, Mich.
"American Machinist," Oct. 3, 1918



Longitudinal movement of table, 12 in.; vertical movement of table, 6 in.; transverse movement of table, 6 in.; swing on centers, 8 in.; length of work swung on centers, 17 in.; capacity for internal grinding work, 5 in. deep, 10 in. swing; capacity for grinding drills, from No. 52 to ½ in., 3/32 in. to 1¼ in., or ⅛ in. to 2¼ in. depending on the holder specified; vise jaws, 4 in. wide, 1¼ in. deep; with opening of 2¾ in.; chuck, 3 in. three jaw; speed of main spindle, 1600 r.p.m.; speed of small spindle, 3800 and 8800 r. p.m.; floor space, 42 x 67 in.; net weight, 620 lb.

Grinding Machine, Cutter, Reamer and Drill, No. O, Motor-Driven
Wilmarth & Morman Co., Grand Rapids, Mich.
"American Machinist," Oct. 3, 1918

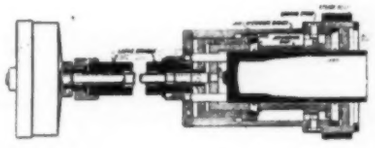


Longitudinal movement of table, 12 in.; vertical movement of table, 6 in.; transverse movement of table, 6 in.; swing on centers, 8 in.; length of work swung on centers, 17 in.; capacity for internal grinding work, 5 in. deep, 10 in. swing; capacity for grinding drills, from No. 52 to ½ in., 3/32 in. to 1¼ in., or ⅛ in. to 2¼ in., depending on the holder specified; vise jaws, 4 in. wide, 1¼ in. deep, with opening of 2¾ in.; chuck, 3 in. three jaw; speed of main spindle, 1600 r.p.m.; speed of small spindle, 3800 and 8800 r.p.m.; floor space, 42 x 67 in.; net weight, 620 lb.

Lapping Machine
B. L. Schmidt Co., Davenport, Iowa
"American Machinist," Oct. 3, 1918

For lapping of the tappet arms of a gasoline engine, but it may be adapted to other like uses. The 12 spindles are raised and lowered automatically by 12 cams mounted on the head or top of each spindle. As the spindles rotate, the special fixtures, which have reciprocating or rotary oscillating movement, receive the tappets, these being loaded while the machine is running, one-third of the fixtures being loaded while the other two-thirds are in operation. The lapping head is made of carbon steel, which is claimed to give it greater wearing resistance.

Shell Chuck, "Paco"
Production Appliances Co., 14 South Jefferson St., Chicago, Ill.
"American Machinist," Oct. 10, 1918



Two sets of jaws are operated independently of each other, each gripping the shell at a separate point and automatically aligning it with the spindle of the lathe. It is claimed that as there is a positive connection of the jaw-carrying and jaw-operating bodies with the lathe spindle through the driving and stop studs the full power of the air is utilized for gripping the work, and hence heavy roughing cuts can be carried without unduly stressing any of the parts of the chuck. The jaws are carried by a continuous round body with apertures only for the jaws and for the studs, and the jaws disappear completely into the body when the chuck is ready to receive the shell.

Drilling Machine, Sensitive
Edlund Machinery Co., Inc., Cortland, N. Y.
"American Machinist," Oct. 10, 1918

Capacity, drills to center of 18-in. circle; maximum distance table to spindle, 21 in.; vertical adjustment of arm, 17 in.; traverse of spindle, 7¾ in.; diameter of spindle, 1 5/16 in.; taper hole in spindle, Morse No. 2; working surface of table, 21¼ x 20 in.; diameter of driving pulley, 9 in.; face of driving pulley, 2¼ in.; size of pan, 29½ x 28 in.; spindle speeds, 380, 660, 950 and 1215 r.p.m. with the drive pulley running at 500 r.p.m.; weight, 825 lb.; floor space, 42 x 37 in.

Patented, Aug. 20, 1918

WEEKLY PRICE GUIDE OF

IRON AND STEEL

The Government Schedule of steel prices went into effect Sept. 24. Pig iron was set at $33 per ton; pig iron differentials were announced by the American Iron and Steel Institute on Nov. 3. Washington announced sheet and pipe prices on Nov. 5. Warehouse prices have been revised, as shown, by agreement between the War Industries Board and the warehouses; new schedule in effect Nov. 15. Effective Apr. 1, the price of basic iron was fixed at $32, and standard Bessemer at $35.20 at Valley furnace, prices of other irons remaining the same as last quarter.

PIG IRON—Quotations compiled by the Matthew Addy Co.:

	Current	One Month Ago
CINCINNATI		
No. 2 Southern	$37.60	$36.60
Northern Basic	34.80	33.80
Southern Ohio No. 2	35.80	34.80
NEW YORK, Tidewater delivery		
Penna. 2X	39.15	34.00
Virginia No. 2	41.70	37.90
Southern No. 2	41.70	40.70
BIRMINGHAM		
No. 2 Foundry	34.00	33.00
PHILADELPHIA		
Eastern Pa. 2X	38.85	33.50*
Virginia No. 2	40.50	37.10†
Basic	36.60	32.00*
Grey Forge	36.60	32.00*
Bessemer	38.80	35.20*
CHICAGO		
2 Foundry Local	34.50	33.50
2 Foundry Southern	39.00	38.00
PITTSBURGH, including freight charge from the Valley		
2 Foundry Valley	35.40	34.40
Basic	34.40	33.40
Bessemer	36.60	36.60

* F.o.b. furnace. † Delivered.

STEEL SHAPES—The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses at the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4.245	$4.245	$5.25	$4.17	$5.00	$4.27	$5.00
Soft steel bars	4.145	4.145	5.00	4.07	4.50	4.17	4.50
Soft steel bar shapes	4.145	4.145	5.00	4.17	4.50	4.17	4.50
Soft steel bands	4.745	4.995	....	....	....	....	....
Plates, ¼ to 1 in. thick	4.495	4.495	10.00	4.42	7.00	4.25	9.00

BAR IRON—Prices per 100 lb. at the places named are as follows:

	Current	One Year Ago
Pittsburgh, mill	$3.50	$4.75
Warehouse, New York	4.75	4.75
Warehouse, Cleveland	4.67	4.95
Warehouse, Chicago	4.10	4.50

STEEL SHEETS—The following are the prices in cents per pound from jobbers' warehouse at the cities named:

	Pittsburgh, Mill, in Carloads	New York			Cleveland		Chicago	
		Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
*No. 28 black	5.00	6.495	6.495	9.50	6.42	8.50	6.52	9.25
*No. 26 black	4.90	6.395	6.395	9.40	6.32	8.40	6.42	9.15
*Nos. 22 and 24 black	4.85	6.345	6.345	9.35	6.27	8.35	6.37	9.10
Nos. 18 and 20 black	4.80	6.295	6.295	9.30	6.22	8.30	6.32	9.05
No. 16 blue annealed	4.45	5.695	5.695	10.20	5.62	8.70	5.72	9.70
No. 14 blue annealed	4.35	5.595	5.595	10.10	5.52	8.60	5.62	9.60
No. 10 blue annealed	4.25	5.495	5.495	10.00	5.42	8.50	5.52	9.50
*No. 28 galvanized	6.25	7.745	7.745	11.00	7.67	10.00	7.77	10.50
*No. 26 galvanized	5.95	7.445	7.445	10.70	7.37	9.70	7.32	10.20
No. 24 galvanized	5.80	7.295	7.295	10.55	7.22	9.55	7.47	10.05

*For painted corrugated sheets add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 5c., all gages.

COLD DRAWN STEEL SHAFTING—From warehouse to consumers requiring at least 1000 lb. of a size (smaller quantities take the standard extras) the following discounts hold:

	Current	One Year Ago
New York	List plus 12%	List plus 25%
Cleveland	List plus 11%	List
Chicago	List plus 13%	List plus 10%

DRILL ROD—Discounts from list price are as follows at the places named:

	Extra	Standard
New York	35%	40%
Cleveland	35%	40%
Chicago	35%	40%

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ten lots is:

	Current	One Year Ago
New York	$15.50–19	$14.00
Cleveland	20.00	15.00
Chicago	19.00	13.50

In coils an advance of 50c. usually is charged.

Note—Stock very scarce generally.

WELDING MATERIAL (SWEDISH)—Prices are as follows in cents per pound f.o.b. New York, in 100-lb. lots and over:

Welding Wire*		Cast-Iron Welding Rods	
5/32, 11, 3/16, 1/4, 7/32, 5/16 No. 8, 3/32 and No. 10 1/8 No. 12 5/32 No. 14 and 7/32 No. 18 No. 20	22.10 to 33.00	5/16 by 12 in. long	16.00
		1/2 by 19 in. long	14.00
		1/4 by 19 in. long	12.00
		5/16 by 19 in. long	12.00
		1/2 by 21 in. long	12.00
		*Special Welding Wire	
		1/4	33.00
		5/16	30.00
		1/2	38.00

* Ver scarce.

MISCELLANEOUS STEEL—The following quotations in cents per pound are from warehouse at the places named:

	New York Current	Cleveland Current	Chicago Current
Tire	4.14	4.07	4.17
Toe calk	5.75	4.65	4.32
Openhearth spring steel (heavy)	8.00	8.00	7.50
Spring steel (light)	11.00	11.25	11.75
Coppered bessemer rods	9.00	8.00	7.07
Hoop steel	4.745	4.75	4.77
Cold-rolled strip steel	8.50	8.25	8.57
Floor Plates	6.245	6.00	6.25

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh; basing card of Nov. 6, 1917, for steel pipe and for iron pipe:

BUTT WELD

Steel			Iron		
Inches	Black	Galvanized	Inches	Black	Galvanized
1/8, 1/4 and 3/8	44%	17½%	3/8 to 1½	33%	17%
1/2	48%	33½%			
3/4 to 3	51%	37½%			

LAP WELD

2	44½	31½%	2	26%	12%
2½ to 6	47%	34½%	2½ to 4	28%	15%
			4½ to 6	28%	15%

BUTT WELD. EXTRA STRONG PLAIN ENDS

1/8, 1/4 and 3/8	40%	22½%	3/4 to 1½	33%	18%
1/2	45%	32½%			
3/4 to 1½	49%	36½%			

LAP WELD. EXTRA STRONG PLAIN ENDS

2	42%	30½%	2	27%	14%
2½ to 4	45%	33½%	2¼ to 4	29%	17%
4½ to 6	44%	32½%	4½ to 6	28%	16%

Stock discounts in cities named are as follows:

	New York		Cleveland		Chicago	
	Black	Galvanized	Black	Galvanized	Black	Galvanized
3/4 to 3 in. steel butt welded	33%	16%	41%	26%	41.1%	26.1%
3½ to 3 in. steel lap welded	15%	+3%	37%	23%	37.1%	23.1%

Malleable fittings, Class B and C, from New York stock sell at list price. Cast iron, standard sizes, 10 and 5%.

METALS

MISCELLANEOUS METALS—Present and past New York quotations in cents per pound, in carload lots:

	Current	One Month Ago	One Year Ago
Copper, electrolytic	26.00*	26.00	23.50
Tin in 5-ton lots	78.50	83.00	62.00
Lead	8.05	8.05	8.50
Spelter	9.75	9.50	8.50

*Government price.

ST. LOUIS

Lead	7.75	7.75	8.00
Spelter	9.50	9.25	8.25

At the places named, the following prices in cents per pound prevail for 1 ton or more:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Copper sheets, base	38.00	38.00	35.00	38.00	33.00	38.00	34.00
Copper wire (carload lots)	35.00	35.00	38.50	35.00	33.00	38.00	33.50
Brass sheets	39.75	39.75	40.00	40.50	33.25	38.00	35.00
Brass pipe	46.00	46.00	43.00	42.50	41.00	44.00	42.00
Solder (half and half) (case lots)	58.00	58.00	39.25	50.50	37.00	65.00	39.00

Note:—Solder very scarce.

Copper sheets quoted above hot rolled 16 oz., cold rolled 14 oz. and heavier, add 1c.; polished takes 1c. per sq.ft. extra for 20-in. widths and under; over 20 in., 2c.

BRASS RODS—The following quotations are for large lots, mill, 100 lb. and over, warehouse; 25% to be added to mill prices for extras; 50% to be added to warehouse price for extras:

	Current	One Year Ago
Mill	$37.75	$29.00
New York	34.25	35.00
Cleveland	38.50	34.00
Chicago	29.50	37.00

SHOP MATERIALS AND SUPPLIES

ZINC SHEETS—The following prices in cents per pound prevail:

Carload lots f.o.b. mill 15.00

	In Casks		Broken Lots	
	Current	One Year Ago	Current	One Year Ago
Cleveland	18.75	20.00	18.40	20.50
New York	17.00	21.00	17.50	21.25
Chicago	22.00	21.00	21.50	21.50

ANTIMONY—Chinese and Japanese brands in cents per pound, in ton lots, for spot delivery, duty paid:

	Current	One Year Ago
New York	14.00	15.00
Chicago	15.00	16.25
Cleveland	17.125	16.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York		Cleveland		
	Current 1918	One Yr. Ago 1918	Current 1918	One Yr. Ago	Chicago
Copper, heavy and crucible	24.00	24.00	24.00	24.75	23.50
Coppepr, heavy and wire	22.50	23.00	23.50	24.00	23.50
Copper, light and bottoms	20.50	21.00	21.50	22.00	21.75
Lead, heavy	7.25	8.00	.....	8.00	7.50
Lead, tea	5.50	6.75	7.50	6.00	6.50
Brass, heavy	14.75	15.25	16.50	17.00	23.50
Brass, light	11.00	11.50	12.50	13.00	12.85
No. 1 yellow brass turnings	13.75	16.25	14.00	16.00	14.00
Zinc	6.50	6.00	6.00	6.00	6.50

ALUMINUM—The following prices are from warehouse at places named:

	New York	Cleveland	Chicago
No. 1 aluminum, guaranteed over 99% pure, in ingots for remelting (1-15 ton lots), per lb.	33.20c.	32.20c.	33½c.

This is the Government price for lots of from 1 to 14 tons.

COPPER BARS from warehouse sell as follows in cents per pound, for ton lots and over:

	Current	One Year Ago
New York	32.00	41.00
Chicago	38.00	41.00
Cleveland	36.50	39.00

BABBITT METAL—Warehouse price per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	95.00	70.00	93.00	69.75	96.00	70.00
Commercial	50.00	40.00	23.00	24.50	25.00	25.00

SHOP SUPPLIES

NUTS—From warehouse at the places named, on fair-sized orders, the following amount is deducted from list:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
* List plus.						
Hot pressed square	$2.50*	List	$1.25	$1.65	$0.98	$2.00
Hot pressed hexagon	2.50*	List	1.05	1.50	.78	2.00
Cold punched hexagon	2.50*	List	.75	1.25	1.00	1.50
Cold punched square	2.50*	List	.75	1.25	1.00	1.50

Semifinished nuts sell at the following discounts from list price:

	Current	One Year Ago
New York	40%	50%
Chicago	50%	50%
Cleveland	50 + 10%	50%

MACHINE BOLTS—Warehouse discounts in the following cities:

	New York	Cleveland	Chicago
⅝ by 4 in. and smaller	30%	40+10%	37%
Larger and longer up to 1 in. by 30 in.	15%	20+ 5%	25—5%

WASHERS—From warehouses at the places named the following amount is deducted from list price:

For wrought-iron washers:
New York ..... $2.50 Cleveland ..... $1.00 Chicago $2.50

For cast-iron washers the base price per 100 lb. is as follows:
New York ..... $5.00 Cleveland ..... $4.00 Chicago $4.50

CARRIAGE BOLTS—From warehouses at the places named the following discounts from list are in effect:

	New York	Cleveland	Chicago
⅝ by 4 in. and smaller	30%	45%	32½%
Larger and longer up to 1 in. by 30 in.	15%	20+5%	20%

COPPER RIVETS AND BURS sell a the following rate from warehouse:

	Rivets		Burs	
	Current	One Year Ago	Current	One Year Ago
Cleveland	List plus 10%	List plus 10%	List plus 10%	List plus 10%
Chicago	List price	List price	List plus 20%	List price
New York	20% from list	List plus 10%	List plus 20%	10-2½% from list

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ½ and smaller	30%	45—5%	40%
Tinned	30%	45—5%	40%

Button heads, ¾, ⅞, 1 in diameter by 2 in. to 5 in. sell as follows per 100 lb.
New York..$5.65 Cleveland..$5.15 Chicago..$5.67 Pittsburgh..$4.65
Coneheads, same sizes:
New York..$5.75 Cleveland..$5.25 Chicago..$5.77 Pittsburgh..$4.75

MISCELLANEOUS

SEAMLESS DRAWN TUBING—The base price in cents per pound from warehouse in 100-lb. lots is as follows:

	New York	Cleveland	Chicago
Copper	51.00	38.00	39.50
Brass	42.00	40.00	44.00

For immediate stock shipment 3c. is usually added. The prices of course vary with the quantity purchased. For lots of less than 100 lb. but not less than 75 lb., the advance is 1c.; for lots of less than 75 lb. but not less than 50 lb., the advance is 2½c. over base (100-lb. lots); for less than 50 lb. but not less than 25 lb., 5c. should be added to the base price: and for quantities under 25 lb. the increase above base is 10c.

TIN PLATES—Warehouse prices per box:

Coke tin plate, 14 x 20:

	Cleveland		Chicago	
	Current	One Yr. Ago	Current	One Yr Ago
100 lb.	$9.17½	$12.00	$10.60	$11.75
I. C. 107 lb.	9.42½	12.17½	10.70	11.90

Terne plate, 20 x 28:

Base Weight	Net Weight	Coating				
100 lb.	200	3	18.95	18.95	19.10	17.90
I. C.	214	8	19.25	19.25	19.40	18.25
I. C.	270	8	21.75	21.75	21.40	20.35
I. C.	218	12	21.75	21.75	22.60	19.25
I. C.	221	15	22.50	22.50	22.10	19.50
I. C.	226	30	23.25	23.25	22.60	20.50
I. C.	231	25	24.50	24.50	23.10	21.30
I. C.	236	30	25.75	25.75	23.60	22.25
I. C.	241	35	26.75	26.75	25.10	23.25
I. C.	246	40	28.00	28.00	25.60	24.55

NOTE—New York prices furnished on application to dealers. Price varies according to whether the plates are wanted for work essential to the war or for nonessential work.

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Current	One Year Ago		
White	11.00 to 13.00	13.00	16.50	12.00 to 16.50
Colored mixed	8.50 to 12.00	12.00	13.00	11.50 to 14.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13¼ x 13¼	13¼ x 20½
Cleveland	52.00	68.00
Chicago	48.00	50.00

SAL SODA sells as follows per 100 lb.:

	Current	One Month Ago	One Year Ago
New York	$1.75	$1.75	$1.75
Philadelphia	1.75	1.75	1.75
Cleveland	2.40	2.40	2.10
Chicago	2.00	2.00	2.00

ROLL SULPHUR in 360-lb. bbl. sells as follows per 100 lb.:

	Current	One Month Ago	One Year Ago
New York	$4.30	$4.30	$4.30
Cleveland	4.60	4.60	4.50
Chicago	4.00	4.00	3.80

COKE—The following are prices per net ton at ovens, Connellsville, and cover the past four weeks:

	Oct. 17	Oct. 10	Oct. 3	Sept. 26	Sept. 19
Prompt furnace	$6.00	$6.00	$6.00	$6.00	$6.00
Prompt foundry	$7.00	$7.00	$7.00	$7.00	$7.00

FIRE CLAY—The following prices prevail:

		Current
Chicago	450-lb. bbl.	$2.50
Cleveland	375-lb. bag	2.50

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Yr. Ago
Raw in barrels	$1.90	$1.23	$2.00	$1.30	$1.81	$1.27
5-gal. cans	2.00	1.33	2.15	1.40	2.01	1.37

WHITE AND RED LEAD in 500-lb. lots sells as follows in cents per pound:

	Red				White			
	Current		1 Year Ago		Current		1 Year Ago	
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	14.00	14.50	12.25	12.50	14.00	12.50		
25 and 50-lb. kegs	14.25	14.75	12.50	12.75	14.25	12.25		
12½-lb. keg	14.50	15.00	12.75	13.00	14.50	12.50		
5-lb. cans	——	——	14.25	14.00	16.00	14.50		
1-lb. cans	——	——	14.25	14.50	17.00	14.50		

NEW *and* ENLARGED SHOPS

Consult the Buying Section when in need of machinery or supplies

WASHINGTON, D. C.

The Navy aims to give information regarding its purchases to all manufacturers known to be in a position to supply its demand. Owing to the need of prompt action in the cases of all machine tools hereinafter listed, the Navy cannot arrange to permit a postponement of the opening of bids if the manufacturers are able to secure bidding forms and submit their bids prior to date fixed for opening.

In case time does not permit this, it will be appreciated if any manufacturer not receiving information directly regarding these purchases will notify the Purchasing Division, Bureau of Supplies & Accounts, Navy Department, Washington, D. C., in order that the firm's name may be properly listed for all future purchases.

The Bureau of Supplies and Accounts, Navy Department, will receive bids furnishing machines and machine tools as follows:

Oct. 28—Schedule No. 6572½, 1 caulking machine, delivery Philadelphia, Penn.

Nov. 1—Schedule No. 6517½, 4 milling machines, delivery Washington, D. C.

Schedule No. 6518½, 10 engine head, geared and milling turret lathes, delivery Pensacola, Fla.

Schedule No. 6541½, 5 high speed hack saws, delivery Philadelphia, Penn.

Schedule No. 6547½, 1 tool grinder, delivery Washington, D. C.

Schedule No. 6549½, 1 pedestal grinder, delivery Washington, D. C.

Schedule No. 6551½, 2 crank shapers, delivery Washington, D. C.

Schedule No. 6552½, 1 cutting machine, delivery Washington, D. C.

Schedule No. 6519½, 8 milling machines, delivery Philadelphia, Penn.

Schedule No. 6589½, 2 charging machines, delivery South Charleston, W. Va.

Schedule No. 6594½, 1 machine dowel and rod, delivery Washington, D. C.

Schedule No. 6609½, 1 variety wood machine, delivery Lens, Del.

Schedule No. 6613½, 48 stretch caliper, hack saw, blade awls, delivery Brooklyn, N. Y.

Schedule No. 6619½, 1 automatic plug machine, delivery Boston, Mass.

Nov. 8—Schedule No. 6561½, miscellaneous machines and furnishing force cylinders, delivery f.o.b.

Schedule No. 6631½, 8 plain milling and grinding machines, delivery Washington, D. C.

The Bureau of Supplies and Accounts, Navy Department, received bids furnishing machines and machine tools as follows:

Schedule No. 5900½, Class 953 and 954, trimming machines, delivery South Charleston, W. Va., from Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn., (953) $16,720; (954) $37,602; Niles-Bement-Pond, 111 Broadway, New York City, (593) $15,900; (954) $29,400.

Schedule No. 6169½, Class 1419, planers and jointers, delivery Brooklyn, N. Y., from J. A. Fay & Egan Co., John and Front St., Cincinnati, Ohio, $4489, alternate $5290; Fairbanks Co., Colorado Bldg., Washington, D. C., $4705; Kemp Machinery Co., 223 North Calvert St., Baltimore, Md., $6460, alternate $5560; Manning, Maxwell & Moore, 119 West 40th St., New York City, $4263; D. Nast Machinery Co., Bourse Bldg., Philadelphia, Penn., $4338, alternate $4750; D. B. Smith Machine Co., Smithville, N. Y., $4614; Ward Motor Vehicle Co., South Fulton Ave., Mt. Vernon, N. Y., $7519, (part bid); P. B. Yale Machinery Co., Beloit, Wis., $5050; American Woodworking Machinery Co., 591 Lyell Ave., Rochester, N. Y., $4738; Oliver Machine Co., 50 Church St., New York City, $7579, alternate $7734; Hall & Brown Woodworking Co., 1913 Broadway, St. Louis, Mo., $6080.

Schedule No. 6085½, Class 1423, woodworkers' lathe, from J. A. Fay & Egan Co., John and Front St., Cincinnati, Ohio, $897; alternate $1004; American Woodworking and Machinery Co., 591 Lyell Ave., Rochester, N. Y., $879, alternate $909.

Schedule No. 6238½, Class 1448, molding machinery, delivery Washington, D. C., from Cleveland Osborn Manufacturing Co., Cleveland, Ohio, $250; Vulcan Engineering Sales Co., 1765 Elston Ave., Chicago, Ill., $250.

Schedule No. 6110½, Class 1167, end mills and cutters, delivery Washington, D. C., from Brown & Sharpe Manufacturing Co., Promenade St., Providence, R. I., $8435; Detroit Twist Drill Co., 634-66 West Fort St., Detroit, Mich., $6851, (part bid); Illinois Tool Works, 154 East Erie St., Chicago, Ill., $11,023; Kemp Machinery Co., 223 North Calvert St., Baltimore, Md., $8933; Lincoln Twist Drill Co., Taunton, Mass., $1544, (part bid); Machine Tool Drill Co., New Bedford, Conn., $9432; National Twist Drill and Tool Co., 1456 Brush St., Detroit, Mich., $8496; National Tool Co., 11200 Madison Ave., Cleveland, Ohio, $8857; Pratt & Whitney Co., 436 Capitol Ave., Hartford, Conn., $8492; Union Twist Drill Co., 70 Munroe St., Athol, Mass., $8495; Barber-Colman Co., River and Loomis St., Rockford, Ill., $8510; L. C. Blanke Co., Inc., 10 Thomas St., New York City, $8458.

METAL WORKING

NEW ENGLAND STATES

Conn., Hartford—The S. K. F. Ball Bearing Co., 330 New Park Ave., has awarded the contract for the erection of a 1 story, 53 x 120 ft. addition to its factory. Estimated cost, $25,000. Noted Oct. 17.

Conn., New Britain—The Stanley Rule and Level Co., 111 Elm St., plans to build a 1½ story, 50 x 130 ft. factory on Whiting St. Estimated cost, $7500.

Conn., New Haven—The United Smelting and Aluminum Co., Schuetzen Park, is building a 1 story, 65 x 130 ft. addition to its plant. Estimated cost, $5000.

Conn., Portland—The Portland Foundry Co., a subsidiary of the Baird Machine Co., Stratford Ave., Bridgeport, has acquired a site and plans to build several additions to its plant.

Conn., Waterbury — The Waterbury Buckle Co., 872 South Main St., has awarded the contract for the erection of a 3 story, 50 x 110 ft. factory. Estimated cost, $35,000. Noted Sept. 26.

Mass., Barre—The C. G. Allen Co., iron founder and machinist, plans to rebuild its plant which was recently damaged by fire. Noted Sept. 19.

Mass., Worcester—The Wyman Gordon Co., manufacturer of drop forgings, has awarded the contract for the erection of a 1 story, 40 x 80 ft. addition to its laboratory testing building.

R. I., Hillsgrove—The Rhode Island Malleable Iron Works plans to build a 2 story pattern storage building in addition to a 100 x 200 ft. foundry to replace the portion of its plant which was recently damaged by fire.

MIDDLE ATLANTIC STATES

D. C., Washington—The Victor Valve Manufacturing Co., 1115 14th St., N. W., is in the market for foundry supplies to include small brass castings, lathes, millers, grinders, drill presses and nickel plating equipment for light manufacturing.

Md., Fairfield—The Union Shipbuilding Co. has awarded the contract for the erection of a 1-story addition to its plant. Estimated cost, $150,000. Noted Sept. 12.

N. J., Blenheim (Blackwood P. O.)—H. Reed, 129 South 5th St., Philadelphia, Penn., will build a 2-story, 75 x 150 ft. machine shop and office building, here. H. L. Shay, 130 South 5th St., Philadelphia, Penn., Arch.

N. J., Bloomfield—The Sprague Electric Co., 527 West 34th St., New York City, will build a 1-story, 75 x 110 ft. grinding building addition to its plant on Watsessing Ave. Estimated cost, $25,000.

N. J., Harrison—The Hyatt Roller Bearing Division of the United Motors Corporation, Middlesex St., is having preliminary plans prepared for a 2 story addition to its plant.

N. J., Jersey City—The Continental Can Co., 111 West Washington St., Chicago, Ill., has acquired a site between 15th and 16th Sts., here, and plans to build a 3 and 4 story plant. Estimated cost, $500,000.

N. J., Newark—The Upson-Walton Co. of New York, 462 Riverside Ave., manufacturer of wire rope, etc., has had plans prepared for the erection of a 2 story, 55 x 137 ft. addition to its plant. Estimated cost, $40,000.

N. J., Trenton—The School of Industrial Arts, 114 North Montgomery St., is building a 2-story, 56 x 65 ft. addition to include a 21 x 87 ft. machine shop, a 21 x 48 ft. tool room, automobile engine laboratory and boiler room, ceramic department, a 13 x 20 ft. ceramic chemistry laboratory, equipment of the same to include ball machine, tubs, etc., a 20 x 30 ft. kiln room, a 21 x 87 ft. woodworking shop, wood finishing room and a 20 x 56 ft. pottery modeling room. Equipment to the amount of from $10,000 to $15,000 will be required.

N. Y., Bolivar—The Pittsburgh, Shawmut & Northern R. R. is having plans prepared for remodeling and rebuilding its railway shops here. H. S. Wilgus, Angelica, Engr.

N. Y., Buffalo—The American Car & Foundry Co., 379 Babcock St., has awarded the contract for the erection of a 1-story, 50 x 121 ft. foundry. Noted Oct. 17.

N. Y., Buffalo—J. Ginthers Son, 425 Broadway, has awarded the contract for the erection of a 2-story, 25 x 100 ft. addition to its iron works. Estimated cost, $3500.

N. Y., Buffalo—The Strong Steel Foundry Co., 33 Norris St., has awarded the contract for the erection of a 1-story, 12 x 18 ft. and 40 x 100 ft. addition to its foundry.

N. Y., Buffalo—The United States Drawn Steel Co., Fidelity Bldg., is having preliminary plans prepared for the erection of an addition to its plant.

N. Y., De Witt—The New York Central R. R. has awarded the contract for the erection of four 1-story, 30 x 60 ft. and 30 x 40 ft. additions to its shops here. G. W. Kittredge, Grand Central Terminal, New York City, Ch. Engr. Noted Sept. 12.

N. Y., Elmira—The Willys-Morrow Co., South Main St., manufacturer of automobile parts, plans to build a 1 story, 58 x 129 ft. reclaiming building. Estimated cost, $15,000.

N. Y., Maybrook—New York, New Haven and Hartford R. R., Meadow St., New Haven, Conn., has awarded the contract for the erection of a 1-story, machine shop and office addition to its shops here. Estimated cost, $10,000.